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EXPERIMENTS WITH FLOATING AND SUSPENDED MAGNETS, ILLUSTRATING THE ACTION OF ATOMIC FORCES, THE MOLECULAR STRUCTURE OF MATTER, ALLOTROPY, ISOMERISM, AND THE KINETIC THEORY OF GASES.

By ALFRED M. MAYER.

I HAVE recently devised a series of new experiments which are so easy to make and so well adapted to illustrate the action of atomic forces and the molecular structure of matter, that I think a description of these experiments will be acceptable to all those who are interested in the study or teaching of science.

Any portion of matter, whether solid, liquid, or gaseous, is forced into a smaller volume when subjected to pressure (in other words, matter is compressible), and when this pressure is removed, the matter expands into its original volume. This shows two things: first, that the matter of which the body is formed does not really fill all the space which the body appears to occupy; and, secondly, that in the body is a force which, acting from within outward, resists the outward pressure and expands the body to its original volume when this pressure is removed.

There are several instances where a volume of one liquid when mixed with an equal volume of another liquid does not form a mixture of two volumes, but their combined volume is considerably less than the sum of their separate volumes. Thus, when one mixes one volume of water with an equal volume of alcohol, their combined volume is less than the sum of the volumes of the water and alcohol before mixture. These experiments show that the spaces which the volume of water and alcohol appeared to fill were not really filled with water and alcohol matter, but that vacant spaces (physical pores) existed in these liquids. In other words, these liquids are *porous* one to the other. This shrinkage of the mixed alcohol and water is all the more remarkable when we remember that each additional atmospheric pressure on water lessens its volume only by the $\frac{1}{20000}$th part.

These phenomena of compressibility and porosity, which we have just described, may be explained by supposing that all matter is built up of very minute parts, and that these parts do not touch, but are kept asunder by the action of two forces which exactly balance one another. One of these forces is a constant attraction which tends to bring these minute parts together; the other is a force of repulsion which constantly tends to separate them.

There are two laws in chemistry which lie at the foundations of that science, and which cannot well be explained except by the assumption that matter is really formed of these minute parts, and, also, that the minute parts have definite and constant forms, volumes, and weights. The volumes and weights, and probably the forms, differ with the different kinds of matter. These minute parts are called *atoms*. These atoms are assumed to be ruled by forces of attraction and repulsion, so that when these two forces exactly balance, the atoms will be separated and arranged in a geometric manner around some central point. Such a combination of atoms is called a *molecule*. A molecule may be defined as the smallest portion of any kind of substance which can have the chemical properties of the substance, while an atom may be defined as the smallest particle of elementary matter which forms one of the components of a molecule. Thus a molecule of water may be supposed to be formed of two atoms of hydrogen with one of oxygen. This is the smallest mass of these two substances which can form water, for if one of these atoms should be removed from the molecule, the molecule would break up into hydrogen and oxygen.

The first of the two laws of chemistry, above referred to, is this: The same body is invariably composed of the same elements united in the same proportions. Thus, water, no matter how formed, is composed of one part by weight of hydrogen united to eight parts by weight of oxygen; and carbon dioxide, whether formed by a burning candle, by the combustion of carbon in oxygen, or by breathing, is always formed of six parts by weight of carbon united to sixteen parts by weight of oxygen. This law is readily explained by the suppositions we have made as to the existence of atoms and the structure and nature of molecules. For, since the molecule of the same matter is always formed of the same number (or weight) of atoms, and since masses of matter are made up of combinations of many molecules, it follows that these masses of matter will have the same proportions by weight of the same elementary atoms as compose the molecules.

The second law is this: When an element unites with another in different proportions, the higher proportions are invariably multiples of the lowest. Thus nitrogen and oxygen unite and form the following five different compounds:

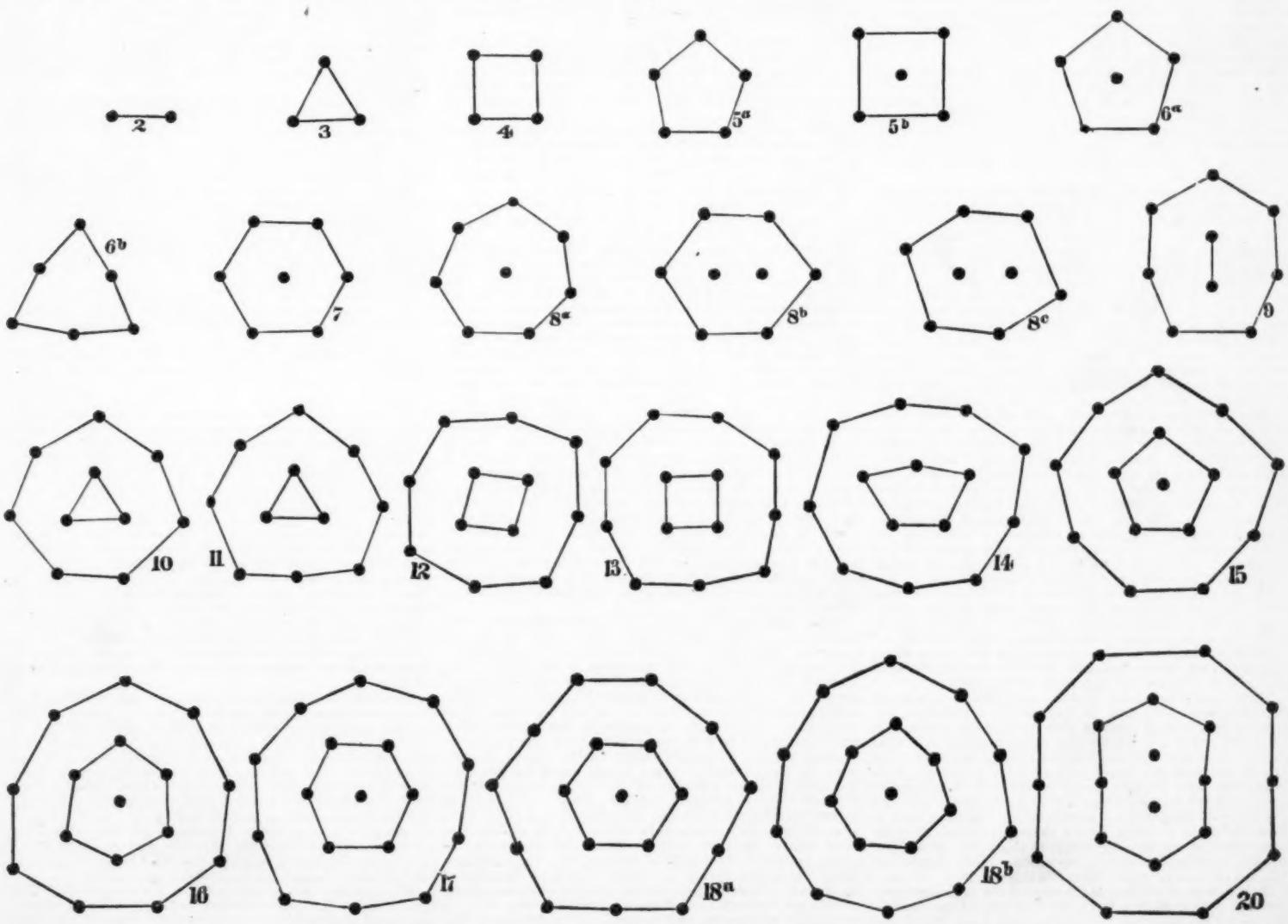
1. Nitrogen monoxide contains 28 of nitrogen and 16 parts of oxygen.
2. Nitrogen dioxide contains 28 of nitrogen and 32 parts of oxygen.
3. Nitrogen trioxide contains 28 of nitrogen and 48 parts of oxygen.
4. Nitrogen tetroxide contains 28 of nitrogen and 64 parts of oxygen.
5. Nitrogen pentoxide contains 28 of nitrogen and 80 parts of oxygen.

In this series of compounds oxygen unites in five different proportions, and if you call the lowest proportion, in the monoxide, *one*, then the proportions of oxygen in these compounds are *one, two, three, four, five*.

This second law may be explained by the supposition that, as we have stated, the molecule is a combination of atoms, and that there is always the same number of these atoms in a molecule of the same substance. Thus, in the case of the combinations of nitrogen and oxygen, the molecule of nitrogen may be supposed as always formed of two atoms of nitrogen, and may be represented thus, **N N**. The molecule of oxygen we may suppose formed of a single atom and may be represented thus, **O**. If this be granted, then, since these molecules unite as *units*, it follows that the various combinations of nitrogen and oxygen *must* take place as the second law states, and these compounds may be represented by the following table of the combinations of the symbols **N N** and **O**:

Nitrogen monoxide = **N N O**.
" dioxide = **N N O O**.
" trioxide = **N N O O O**.
" tetroxide = **N N O O O O**.
" pentoxide = **N N O O O O O**.

There is a law, known as the law of Avogadro, which states that equal volumes of gases contain equal numbers of molecules; but as atoms of different elementary substances are of different sizes and weights, it follows that molecules



EXPERIMENTS WITH FLOATING AND SUSPENDED MAGNETS.

of different substances contain different numbers of atoms. There are reasons for believing that these atoms in the molecules are separated from each other by spaces which greatly exceed the diameter of an atom, and that the diameter of a molecule is about $\frac{1}{10000000}$th of a millimeter. To aid the mind in approaching a conception of the size of molecules, Sir William Thomson gives this illustration: Imagine a drop of rain, or a glass sphere the size of a pea, magnified to the size of the earth, the molecules in it being increased in the same proportion. The structure of the mass would then be coarser than a heap of fine shot, but probably not so coarse as that of a heap of cricket-balls.

According to the kinetic theory of gases these molecules are constantly in motion, striking against each other and against the walls of the vessel which holds the gas. The free path of one of these molecules is supposed to be about 5,000 times the diameter of a molecule, or about $\frac{1}{5000}$th of a millimeter. The velocity of translation of these molecules is supposed to be different for different gases; for air and oxygen gas it is supposed to be at the rate of 465 meters in one second, and the number of collisions which each molecule of oxygen makes in a second is about 7,646,000,000.

The phenomena of the diffusion of gases show that the molecules of gases are really in constant motion, for when two gases of the same temperature are placed in communicating vessels, the dense gas in the lower vessel will rise and mix with the rare gas, while the rare gas descends and mixes with the dense gas. This motion is supposed to be the direct result of the constant and rapid motion of the molecules.

These molecules move in straight lines, and impinging against each other and against the walls of the vessel containing them they thus cause the pressure, or tension, which a gas always exerts on the walls of the containing vessel. This pressure is evidently due to the conjoined effects of the number and the velocity of the molecules. If the number of molecules in the vessel is increased, the pressure of the gas against the vessel is increased directly with the increase of density. This relation existing between density and pressure is stated in the law of Boyle and Mariotte.

If the velocity of the molecular motions is increased the number of their collisions is increased, the temperature of the gas rises and it expands. Since equal volumes of all gases have the same number of molecules and as the velocity of the molecular motion in different gases is inversely as the square root of the density of these gases, it follows that the volume of a given gas under constant pressure varies directly as the absolute temperature. This statement is known as the law of Charles.

The collisions of the molecules cause their atoms to vibrate, and these vibrations are imparted to the ether, and thus rays of light and all radiant energy are produced, rays of different wave-lengths being caused by different rates of atomic vibration. As the density of a gas is increased the bands in its spectrum widen and finally a certain degree of condensation causes the gas to give a continuous spectrum. This is explained by the supposition that increase of density in the gas shortens the path of the molecule from one collision to the next, and thus the collisions becoming more frequent the atomic vibrations become more and more complex and at last rays of wave-lengths corresponding to all the rays of the spectrum are sent out from the vibrating atoms.

We have given this short and necessarily imperfect account of modern conceptions of the molecular structure of matter merely to serve as a text which I purpose illustrating by my recently invented system of experiments with floating and suspended magnets.

We have seen that the atoms mutually attract and repel and thus a definite size and form is given to the molecule. I obtain mutually repellent bodies by magnetized needles floated vertically in water. The force of attraction I obtain either by bringing a magnet over the floating needles or by suspending the needles by fine fibers, and in this case their gravitation toward the vertical balances the repulsion between the needles.

I will now show how to proceed in these experiments. Get a couple dozen of "Milward's needles, No. 6, betweens," and draw each one six times from point to eye over the N end of a magnet. You will thus have made these needles magnetic, and the point of each is of north polarity, while the eye is of south polarity. From the N. Y. Cork Cutting Co., 45 Fulton Street, you can purchase for 10 cents a gross of corks, one-half inch long and $\frac{3}{4}$ of an inch in diameter. Cut each cork in halves. Then with a needle, stuck in a pen handle as an awl, run a hole lengthwise through the center of each of these corks. Through the hole thus made in the cork you push the magnetized needle till its eye is just above the top of the cork. Throw several of these needles into a basin of water and you will observe that they float upright with the top of the cork on a level with the surface of the water. As similar poles of these little magnets are opposite each other it follows that they are mutually repellent bodies. Now bring down over them the N pole of a cylindrical bar magnet and observe what takes place. Each needle marches up to a position under the magnet, and as needle after needle arrives each moves to give the new comer room and to preserve the proper distance and direction with respect to him. Here the N pole of the magnet held over the needles gives us the force of attraction, because this pole attracts all of the south and upper poles of the needles, and thus is obtained the counterpart of the attraction existing between the atoms of the molecule.

Fig. 1 represents a bowl, C, in which are floating six magnets. The vertical magnet M, causes these needles to arrange themselves in a pentagon with one of the needles in its center, as shown in a magnified image on the screen.

In the accompanying figures are given the forms of arrangement, or, as we shall call them, *the configurations*, of groups of numbers of needles, from two to nineteen.

These figures have been obtained as follows: A magnet, 38 centimeters long and 15 millimeters in diameter, was clamped in a vertical position with its N end 60 millimeters above the end of a needle floating directly under it. After each configuration had come to rest I tipped the upper end of each needle with a dot of printer's ink. A piece of cardboard was then brought down on the ends of the needles and I obtained on the card a print of each needle and thus got the exact form of each configuration. Around each of these points as a center I drew the small circles. The figures attached to the configuration show the number of needles entering into their composition. These figures are reduced to one-half size to illustrate this article.

As has been stated before the needles are mutually repellent and thus exhibit a force like that which keeps asunder the atoms in a molecule. The attractive force which just balances these repulsions is obtained from the magnet. As the needles move freely in a plane, we have here reproduced a freedom of motion similar to that existing in the space where are the real atoms and molecules. And here I will say that I am merely giving illustrations and suggestions as to molecular structure and atomic actions, and my reader should be careful to remember that molecules and atoms are grouped *in space* and *not in a plane* like our floating needles.

Place seven needles in the water and obtain configuration No. 7. Lift the magnet higher and the figure expands, since the attractive action on the needles is weakened and the repellent force between the needles has the ascendency, and the needles move away from the central needle until they reach new positions of equilibrium. Lower the magnet and the needles move inward toward the central one, and the figure contracts. Now vibrate the magnet by lifting it and lowering it over the needles; the figure vibrates in a horizontal plane, keeping time with the vibrations of the magnet in a vertical line. This action may serve to illustrate how the atoms in the molecule *may* vibrate, though there are reasons for believing that the nature of their vibration is more correctly represented by experiments (to be described) with *suspended* magnets.

Some of the configurations are stable, others are unstable, and are sent into stable forms by vibration. Thus, Fig. 5 *b* will often be sent by vibration into the more stable form of 5 *a*. Similarly 6 *b* may be vibrated into 6 *a*, and 8 *b* into 8 *c*. These changes in form serve to illustrate the changes in the molecular structure of bodies often produced by heat and light, and even by contact of a foreign body, as when water,

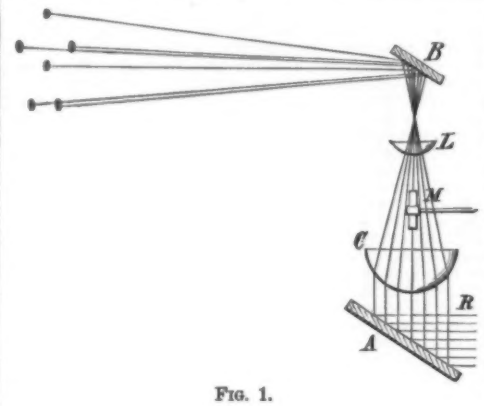


FIG. 1.

cooled below 0° C., on agitation suddenly changes into ice, or as when the yellow crystals of mercuric iodide are touched with a glass rod and become scarlet with a perceptible motion of their particles, or when a supersaturated solution of disodium sulphate solidifies on dropping into it a crystal of this substance. Water and ice have exactly the same chemical composition, and so have the yellow and the scarlet mercuric iodide; and the change of water into ice, of the yellow mercuric iodide into the scarlet, and of the liquid disodium sulphate into the solid, must be the result of a new arrangement of the atoms and molecules of these substances.

These vibrations, when of great extent, and when they take place on a large fluid surface, may cause the exterior needles to go beyond the attractive action of the vibratory period of the magnet, and thus may be illustrated decomposition by actinic action and by heat, or the dissociation of a compound by heat.

If two or more configurations are set in vibration, each by the action of its own superposed magnet, one vibrating system may appropriate to itself one or more atoms of its neighboring configuration, and thus is illustrated the decomposition of one body by the action of another.

The most interesting, however, of all experiments with our little floating magnets are those illustrating the phenomena of *allotropy* and of *isomerism*.

It is well known that an elementary substance may exist under very different forms. By the action of heat, electricity, etc., an element may have its physical and chemical properties so changed that no one would suppose that the different bodies thus made out of one and the same element were really all of the same substance; yet the body remains elementary under the different appearances, for it is impossible by any means of subtraction to get anything but the elementary substance from it. The fact that the same elementary substance may have different physical and chemical properties is called *allotropy* (from *allos, other*, and *tropos, mode*). Phosphorus, sulphur and carbon give instances of allotropy. Thus graphite and the diamond are both carbon, yet how different are they. One is soft, opaque, black, and with a metallic luster; the other is the hardest of bodies, transparent, and resplendent by its refractive action on light. Graphite is a good conductor of electricity; crystallizes in small six-sided tables which belong either to the hexagonal or monoclinic system, and have a specific gravity of 2·2; while the diamond is a bad conductor of electricity, crystallizes in the monometric system, and has a specific gravity of 3·5; and it should here be remembered that whenever an element or a compound takes two different crystal-forms, these different forms always differ in their density.

These phenomena of allotropy are well illustrated by the configurations which are formed of the same number of magnets. Take Figs. 5 *a* and 5 *b*. The first is a pentagon. The second is a square with a magnet in its center. The forces in these floating magnets and in the superposed magnet remain the same in each configuration; these forces differ only in their directions. Thus we see how the same atoms acted on by forces of the same strength, but having different directions, or *polarity*, may produce very different forms. We may take 5 *a* for an illustration of the atomic arrangement in the diamond, while 5 *b* may stand for graphite. But there is always a change of density accompanying the different forms in allotropy, and this fact is also illustrated by configurations 5 *a* and 5 *b*. In bodies formed of the same kind of elementary atoms, as in allotropy, it is evident that their relative densities will be directly as the number of atoms contained in the unit of volume. As our configurations illustrating allotropy contain the *same* number of magnets, it follows that the *relative densities* of these configurations are *inversely as their areas*. Now the area of 5 *a* is 818 square millimeters, and the area of 5 *b* is 992 square millimeters, hence the density of 5 *a* is to the density of 5 *b* as 992 is to 818. Thus we see how the atomic arrangement in 5 *a* may stand for the diamond, while 5 *b* may stand for graphite.

Numerous instances exist in chemistry of the same elements combined in the same proportion, yet producing bodies crystallizing in different forms, and having different densities, color, transparency, hardness, etc. This phenomenon, similar to allotropy, is termed *isomerism*, to distinguish it from allotropy, which is restricted to similar phenomena taking place with the elements, while isomerism refers to combinations of elementary substances. Thus, calcium carbonate crystallizes in two forms differing in density, viz., as calc spar of a specific gravity of 2·72, and as arragonite of a specific gravity of 2·93. Configuration 6 *a* may stand for the molecular arrangement in calc spar, while 6 *b* may stand for that in arragonite. The relative densities of these two configurations are as 208 to 247.

A very marked example of isomerism is given in titanic acid, which crystallizes in three distinct forms: as *Anatase*, sp. gr. 3·82; as *Brookite*, sp. gr. 4·02, and as *Rutile*, sp. gr. 4·25. These three isomers may be illustrated by Figures 8 *c*, 8 *b*, and 8 *a*, which have respectively the areas of 382, 364, and 360.

Butyric acid and acetic ether are isomers, each being formed of 4 atoms of carbon, 8 of hydrogen, and 2 of oxygen. Of these organic compounds, Professor Cooke says in his "New Chemistry:"

"The first, butyric acid, is an oily liquid, with whose smell we are only too familiar, since, when formed in rancid butter, it imparts to this article of our food its peculiarly offensive odor. But, though, as the odor shows, it must slowly volatilize at the ordinary temperature, it does not boil lower than 156° C., and does not easily inflame. Further, as its name denotes, it has the qualities of an acid, reddening litmus paper, and causing an effervescence with alkaline carbonates.

"Utterly different from this offensive acid is the second substance, which we call acetic ether, a very limpid liquid, with a pleasant fruity smell, highly volatile, boiling at 74°, and inflaming with the greatest ease. Notice, also, that it does not in the least affect the colors of these sensitive vegetable dyes.

"Yet butyric acid and acetic ether have exactly the same composition, and the same vapor density. * * * Here, then, we come face to face with a most remarkable fact. For, to affirm no more than can be absolutely demonstrated, this pleasant odor of apples and this disgusting smell of rancid butter come from substances consisting of the same elements united in the same proportions. What, then, can be the cause of the difference? We cannot allow such a fundamental fact as this to pass unchallenged. It is evident that there is an all-important condition which has escaped our elementary analysis. The circumstances demand investigation, and it would be a disgrace to our science not to attempt to answer the question. Can you wonder, then, that for the past ten years a great part of the intellectual force of the chemists of the world has been applied to the problem? The answer they have obtained is that the difference of qualities depends on molecular structure, and that the same atoms arranged in a different order may form molecules of different substances having wholly different qualities."

Our needles illustrate very neatly the molecular actions which must take place when water expands on freezing, and the similar actions which occur when melted bismuth, antimony, and cast iron solidify. One volume of water at 0° Centigrade expands into about one and a tenth volume of ice on freezing. It happens that the area of Fig. 5 *b* is greater than the area of Fig. 5 *a*, by about one-tenth; so that the increase in area which takes place when the pentagon, 5 *a*, changes into the square with a needle in the center, 5 *b*, represents the increase in volume of the water when it changes into ice.

The examination of the configurations of the floating magnets shows that the arrangement of the needles in these configurations follows certain laws which are not without interest. I find that the configurations may be divided into Primary, Secondary, Tertiary, etc. classes. Figures 2 to 8 *a* (the heptagon with one in the center) are the primary configurations; then in the secondary configurations formed of from 9 to to 19 needles inclusive, the primaries, it will be noticed, form their *nuclei*. Thus, configurations 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, and 19 have respectively for nuclei configurations 2, 3, 3, 4, 4, 5, 6, 7, 7, 7, 8. Configurations formed of over 19 needles form the tertiaries, and the secondary configurations become their nuclei.

It remains to explain other ways of obtaining these configurations without the use of floating self-repellent bodies, and to show how these phenomena may be exhibited before large audiences.

In the experiments described above we have used magnets floating on water as the self-repellent bodies, and the superposed magnet has supplied the attractive force. Instead of floating the magnets you may suspend them by fine silk fibers and use the action of gravitation as the force which tends to bring the needles together, by pulling them inward toward the vertical line passing through the center of the configurations. Or, as suggested by my friend Professor Rood, you may suspend gilt pith balls by silk threads, and get repulsive action between them by charging them with like electricity. This modification of the experiment is peculiarly adapted to illustrate the modern ideas in reference to the molecular motions in gases. This hypothesis is known as the kinetic theory of gases. If one suspended configuration be brought near another, the approach causes the needle in each configuration to enter into vibration, and here we have illustrated the atomic vibrations in the molecule. Also, when a suspended configuration of needles is brought against a sheet of paper, we have pressure produced on the paper by the repulsive force of the needles developed on one of their number touching the surface. This may give an illustration of the pressure produced by the molecular motion of gases.

To exhibit these experiments before a large audience it is best to use short magnets made as follows: Magnetize the needles as already described, then take a needle and place it between the flat jaws of a pair of pliers, and snap off the eye end by a pair of cutting pliers close to the jaws of the other pliers. You will thus form a series of magnets about $\frac{1}{4}$ inch long, with their points all of the same polarity. Run each of them through a thin section of cork to float it.

Float these needles in a glass tank placed over the condenser of a vertical magic lantern, or you may even float them on the condenser itself, if this be made of an inverted glass shade filled with water (as described in my little book on "Light," of the Experimental Science Series).

Fig. 1 shows the arrangement of the experiment. The rays of light, R, from a heliostat, fall on an inclined mirror, A, placed under the water condenser, C. The needles float on the surface of the water in this condenser. The rays which have passed through the lens, L, are reflected by the

swinging mirror, B, on the distant screen, where they form the images of the floating magnets at I. The magnet is held over the needles at M, by means of a wire which is wrapped round the magnet and serves as a handle. If a long magnet be used it will work well if its pole is brought over the needles by inclining the magnet.

THE APPLICATION OF POLARIZED LIGHT TO THE EXAMINATION OF THE ALKALOIDS OF THE QUININ GROUP.

By HENRY A. MOTT, Jr., Ph. D., E. M.

IT has been known for a long time that a solution of any of the alkaloids of the Quinin Group affects polarized light—that is to say, possesses the power of turning the plane of polarized light either to the right or to the left—but I believe there has never been any practical application made of this fact to facilitate the examination of the alkaloids of this group, with the exception of quinin alone. Having occasion to examine a number of samples of quinin, and having at my disposal the necessary facilities, I determined to apply this property and see if any practical application could be made of it.

The alkaloids which belong to the Quinin Group are: Quinin, Quinidin, Quinicin, Cinchonin, Cinchonidin and Cinchonicin. The relation of these alkaloids to polarized light may be expressed as follows:

QUININ produces a powerful *left-handed* rotation.
QUINIDIN " " *right* " "
QUINICIN " feeble " " "
CINCHONIN " powerful " " "
CINCHONIDIN " " *left* " "
CINCHONICIN " feeble *right* " "

Pasteur considers that quinin and cinchonidin each contain two active groups, one of which produces strong left-handed rotation, the other producing a feeble right-handed rotation. He also regards quinin and cinchonin as each consisting of two groups, one of which exerts a powerful right-handed rotation, and the other a feeble left-handed rotation; and he supposes that in each of these bases, by the agency of heat, the more powerful group is rendered inert, while the weaker one remains unmodified, thus occasioning the effects observed in quinicin and cinchonicin. As these last two alkaloids do not find any use as yet in commerce they will receive no further consideration in this paper. The other four alkaloids are met with in commerce as alkaloids, as sulphates, and in the case of quinin and cinchonin as muriates, and again quinin as bi-sulphate, other salts having but little use, and it is in the condition first mentioned that I propose to consider them.

Before planning a process for the examination of the above mentioned alkaloids, it becomes necessary to bear in mind the following facts:

1st. That the rotating power of a substance is, according to Hesse,* simply the result of the variable action of its factors—viz., the arrangement of the molecules as regards the volume, the solvent, the temperature, the concentration, the chemical combination, the dissociation and other things—and that "there is no real relation between the rotating power of a substance and its molecules." With respect to the temperature, Bouchardat says, "Variation in temperature causes variation in the rotation power of quinin;" but according to Hesse the variation between 15° C. and 25° C. is insignificant.

Dr. John C. Draper† thoroughly investigated the effect of variation of temperature between 25° C. and 470° C., and determined the correction for the same. He also pointed out that the effect of diluting a solution of quinin was to diminish the power of rotation more than the theoretical amount and that the effect is more marked in the first dilution than in the second. According to Bouchardat‡ acids increase the rotating power of quinin solutions, ammonia restoring it to the original amount.

After carefully considering these different points, I have adopted the following method to obtain the *standard* rotation of the several alkaloids and their respective sulphates:

Each alkaloid, sulphate and muriate in a perfectly pure condition was thoroughly dried at 100° C., and 2 gram (2 decigrams) accurately weighed. (As quinin is quite expensive I determined to experiment with as small quantities as possible, and as 2 decigrams gave satisfactory results I continued to adopt that quantity.) The weighed quantity was dissolved in a little water acidulated with two drops of concentrated sulphuric acid and diluted to 50 c. c., thoroughly agitated, and then examined.

The instrument used for the following observations was a Duboscq Saccharometer. The tube of the instrument was thoroughly washed out with the solution, then filled and examined, giving the following results between the temperatures of 17½ and 24° C., which makes a very convenient field for observation:

NAME.	Alkaloid.	Sulphate of the Alkaloid.	Muriate of the Alkaloid.	Bi-sulphate of the Alkaloid.
Quinin	11°·4 left.	9° left.	10° left.	8° left.
Quinidin	12° right.	10° right.		
Cinchonin	10° right.	7°·5 right.	8° right.	
Cinchonidin	7° left.	6°·5 left.		

It might be thought at first that the rotation obtained by the process just described would not represent the true rotation, as Bouchardat has shown that acids increase the rotating power—again, that in the case of the alkaloids a certain amount of sulphate would be formed which would tend to diminish the rotation. The object is to obtain the true rotation under the conditions stipulated, and it matters not so long as the rotations are constant what the rotation would be under different conditions. Alcohol has always been used to obtain the solution of the alkaloids for examination, but as I find acidulated water answers the purposes just as well, and is considerably less expensive, I propose to use the latter. With respect to the instrument used I selected the Duboscq Saccharometer, as I have more occasion to use that instrument than any other, but any saccharometer may be used provided the proper weight of alkaloid is taken. If the Ventyke instrument is used it becomes necessary to weigh out ·3184 gram of the alkaloid or sulphate to be examined, and the results will be precisely the same. The use of the saccharometers for the examination is very convenient, as these instruments are in more common use among chemists

*Annalen der Chemie, 1875.
†Am. Journ. Sci. and Arts, Vol. XL., 1876.
‡Ann. Ch. Phys. [3], IX., 213.

DEPORTMENT OF THE ALKALOIDS WITH REAGENTS.

NAME.	Melting Point.	Solubility in water.	Solubility in alcohol.	Solubility in ether.	Solubility in chloroform.	Solubility in dilute acids.	Solubility in *benzole.	Solubility in †petroleum naphtha.	Solubility in benzole with acid.	Solubility in petroleum naphtha with acid.	Amylic alcohol with acid.	Solubility in ammonia with water.	Solubility in fixed alkali with water.	Solution in chlorine water gives when amonia is added.	Solution in chlorine water gives when $K_4FeC_6N_6$ is added and then ammonia.	Action on Polarized Light.
QUINIA or QUININ, $C_{20}H_{24}N_2O_2$.	Crystals melt at 57° C. Solidify and remelt at 176° C.	In 460 parts at 15° C. In 250 parts at 100° C., containing 5 pr. ct. when saturated.	Soluble in all proportions of cold absolute. Soluble in 2 parts of alcohol 95 per cent.	In 50 parts of absolute. In 60 parts of ordinary.	In 2 parts of chloroform. 100 parts of chloroform dissolve 57·47 parts.	Easily soluble. Soluble in concentrated acids.	Soluble.			Very slightly soluble.	Insoluble.	Slightly soluble.	Insoluble.	An emerald green color.	Rose color at first, afterward becomes red.	Alcoholic solution $a = -141·33°$ at 25° for red ray, $= -121·6°$ at 23·5° and $-129·56°$ at 16° C. For solutions in acetic or sulphuric acids $a = -287·16°$ at 24° C. for transition-tint, $-230·15°$ for red ray. Authority De Vrij and Alluard.
QUINIDIA or QUINIDIN, $C_{20}H_{24}N_2O_2$.	Melts at 160° C.	In 1500 parts of water in the cold cold. In 750 parts of warm boiling water.	In 45 parts of cold absolute. In 3·7 parts of warm ordinary alcohol.	In 90 parts of cold ether.	100 parts of chloroform dissolve 25·3 parts.	Easily soluble.	Soluble.			Insoluble.	Almost insoluble.	Almost insoluble.	Insoluble.	An olive green color, even in solutions containing $\frac{1}{2000}$th. In concentrated solution a precipitate is formed.	Produces a red color, and when reagents are in certain proportions a permanent bulky precipitate.	Solution in absolute alcohol turns the plane $a = +250·75°$ for transition-tint. Authority Pasteur.
CINCHONIA or CINCHONIN, $C_{20}H_{24}N_2O$.	Melts at 257° C.	In 500 parts of boiling water.	In 176 parts of alcohol at 15° C. In 30 parts of at 100° C. boiling 90 per cent.	In 600 parts of ether at 17° C. In 470 parts of chloroform dissolve at 100° C.	Soluble in 46 parts. 100 parts chloroform dissolve 2·5 pts.	Easily soluble.	Soluble.			Insoluble.	Slightly soluble.	Insoluble.	Insoluble.	White precipitate.	Yellowish solution with white precipitate.	An alcoholic solution acidulated with sulphuric acid gives $a = +190·40°$.
CINCHONIDIA or CINCHONIDIN, $C_{20}H_{24}N_2O$.	Melts at 175° C.	In 2680 parts at 17° C. In 1658 parts at 100° C.	In 12 parts of alcohol specific gravity 0·835 at 17° C. In 3·7 parts of boiling absolute.	In 144·5 parts of cold ether. 100 parts of solution contains only ·70 part.	Soluble.	Easily soluble.	Insoluble when cold, slightly when hot.			Insoluble.	Insoluble.	Insoluble.	Insoluble.	The solution is slightly tinted orange red.	Tint of solution yellowish green.	A solution in absolute alcohol at 18° C. gives $a = -144·61°$. Authority Pasteur.

† Petroleum naphtha distills at 40° to 60° C., leaving no residue.

* Benzole (of coal tar) distills at 69° to 87° C., leaving no residue.

The acid used with benzole, naphtha, etc., is H_2SO_4 added to acid reaction and forming sulphates.—See Prac. Org. Anal., by Prescot, p. 128.

than polariscopes; the latter, though, could just as well be employed provided a table was formed for comparisons, as in the above case; this could either be done by experiment or calculation.

Referring to the foregoing table it will be seen that any one of the alkaloids or sulphates and muriates in an elementary condition can be distinguished at once—but when a mixture of one or many of the alkaloids is examined the task becomes more difficult, and only possible under certain conditions.

Before proceeding it will be well to mention some of the substances used to adulterate these alkaloids. Water is a very common adulterant, and MM. Millore and Counnaille* have shown that when the sulphate of quinin is placed in a very moist atmosphere at 62° F. it will take up a large percentage of water—in two cases 28·77 and 33 per cent. were absorbed. Salicin is also employed, and sometimes earthy salts, also gum starch and fatty matters. The more expensive alkaloids quinin and quinidin are also adulterated with varying proportions of the other two.

The following method may be employed for the examination of the members of the Quinin Group, and it will be seen by the use of their property of rotation many valuable indications and results may be obtained, which will greatly facilitate the examination:

EXAMINATION OF A SAMPLE OF UNKNOWN COMPOSITION.

A portion of the sample to be examined should be weighed, dried thoroughly at 100° C., then weighed again; the loss will equal the excess of water. The presence of salicin in quinin may be readily detected by concentrated sulphuric acid, which turns it red.† To 1 part of the suspected salt 6 parts of sulphuric acid may be added, and then 125 parts of water. The salicin separates, and can be obtained by filtration and weighed. It is a white bitter powder, becoming bright red, as stated, with concentrated sulphuric acid. If the alkaloids are adulterated with starch or fatty bodies, a clear solution cannot be obtained, even in large quantities of water.

A small portion should be tested for salts or earthy matter by ignition on a platinum foil; if a residue remains other than carbon this should be examined in the ordinary way, first qualitatively, then quantitatively. If sulphates of lime or other sulphates are found present they should be removed, and the mass then tested for sulphuric acid by dissolving the same in a little water acidulated with hydrochloric acid, and then testing with baric chloride in the usual manner. If sulphuric acid is formed it is known that the substance is composed of sulphates; it becomes necessary then to test the substance to see if it is the sulphate or the bi-sulphate. Another portion should be tested for hydrochloric acid, and if found the substance is composed of muriates of the alkaloids. Two decigrams of the carefully dried substance is then accurately weighed, if the Duboscq instrument is to be used, and dissolved in 50 c.c. of water, to which 2 drops of concentrated sulphuric acid has been added. The solution after being thoroughly agitated is tested between 17½ and 24° C. in the instrument. If the solution is found to be composed of sulphates the second column is referred to; if either of the other salts, their respective columns.

Supposing the first case—if the indication of the instrument is 9° to the left, it is at once known to be pure sulphate of quinin; if less than 9 and more than 6°·5 left, it is known to be composed at least partly of quinin, and more so as it approaches the standard 9° left. If the solution indicates 10° right, then it is definitely known to be pure quinidin; if the indication is less than 10° right and more than 7°·5 right, the solution is known to contain some quinidin, and more as it approaches its standard, 10° right. If the indication of the instrument is 7°·5 right or 6°·5 left, the supposition is that in the first case it is cinchonin and in the second cinchonidin, but nothing definite can be obtained as regards these two indications until further experiments are made, for they may be owing to an admixture of several or of two of the alkaloids—sulphates—still the indications possess considerable value, and the rapidity with which the examination can be made is of course an advantage. For the further examination of the substance I have carefully prepared the table on page 2047, which shows the deportment of the several alkaloids with reagents.

From this table valuable indications can be obtained, especially from the column containing the deportment of the alkaloids dissolved in chlorine water with ammonia and with ferrocyanide of potassium and ammonia. The presence of cinchonin may be demonstrated by Liebeg's method—0·5 gram of the salt is weighed, and added to 5 grams of ether, the mixture is agitated, and 1·5 gram of concentrated ammonia added. If no cinchonin is present, two liquid layers are obtained; if it is present, a layer of this alkaloid is formed directly above the ammonia. The amount of quinin may be directly determined by decanting and evaporating the ethereal solution, and weighing the residue.

Quinidin is also precipitated with cinchonin by ether. Its presence may be demonstrated by dissolving one gram of the sulphate in 30 grams of boiling water, and adding to the solution ammonium oxalate. Oxalate of quinidin being soluble alone remains in solution, on filtering which and adding ammonia the quinidin may be precipitated.

The above test for cinchonin has been modified by M. O. Henry‡ by heating the substance first with ammonia, so as to drive off excess of alkali before adding the ether, cinchonin being slightly soluble in ammonia.

M. Rogers| has also found that 25 grams of ether is necessary for the solution of the quinin in one gram of the sulphate, while 10 grams of ether with two per cent. of alcohol will produce the same effect.

Dr. Wm. Bird Herapath's test for the examination of the alkaloids together or separate becomes quite valuable after a little experience. It consists in adding carefully drop by drop to a solution of the alkaloids in alcohol acidulated with sulphuric or acetic acid (10 pints alcohol and $\frac{1}{10}$th acid) an alcoholic solution of iodine, and keeping the mixture at 130° F. until perfect solution takes place; upon cooling of the liquid, crystals will gradually form. In the case of quinin the crystals are called herapathite and are emerald green when viewed by reflected light, but almost colorless by transmitted light, and present a curious play of colors under various circumstances of position. They polarize light, in which property they are equal if not superior to tourmaline—100 parts of this herapathite, called sulphate of iodo-quinin, if dried on a water bath, represent 56·5 parts of pure quinin. With a little practice the sulphate iodo-quinin can be distinguished from the other salts by the different tint with reflected and transmitted light.§

* Journ. de Pharm., Nov., 1869, p. 379.
† Am. Journ. of Pharm., xvii.—1856.
‡ Journ. de Pharm., March, 1869, p. 204.
| Journ. de Pharm., 3d series, xii., 109; xvi., 327; xxi., 284.
§ Pharm. Journ., Oct., 1864, p. 185, and Am. Journ. Pharm., Jan., 1865.

Mr. Walter Stoddard has found that if a drop of a solution of potassic sulpho-cyanide be added to a saturated neutral solution of the quinin alkaloids, crystals of sulphocyanide of the alkaloids form, which can be readily distinguished one from the other under the microscope.*

Mr. Palen's test for distinguishing quinin from cinchonin is also quite valuable. If a solution of polysulphuret of potassium is added to a solution of these alkaloids, the quinin will be thrown down as a red viscid mass, which hardens on cooling and assumes a resinous mass—whereas cinchonin is separated as a white powder containing sulphur.†

If after a thorough investigation of the substance under examination only cinchonin or cinchonidin are found, the percentage of these alkaloids may be readily calculated from the indication of the instrument. Or if only two of the alkaloids are found, the percentage of each can be calculated by comparing the indication of the instrument with the standard rotation of each alkaloid as given in the table. Combining these facts with those previously stated, it will be seen that the method I have described for examination of the alkaloids of the Quinin Group by their property of turning the plane of polarization becomes quite valuable, as determinations can be made by this process, in most cases, in the space of fifteen minutes, or even less.

ST. LOUIS.

THE census of 1870 surprised and gratified the people of St. Louis, by showing that their city, with 310,869 inhabitants, was the fourth in size in the United States, following in order New York, Philadelphia, and Brooklyn. The city directory recently issued estimates the population of St. Louis, at the close of 1877, at 502,685. Another decade of growth in the same ratio would make St. Louis about as large as New York is to-day.

St. Louis is believed to be the healthiest city on the globe. The registration of deaths is careful and systematic, yet in 1877 the total mortality was but 5,660, or at the rate of 11·1 in 1,000. The mortality of London and Paris, two of the healthiest cities in the world, is about 20 in 1,000; that of Washington and Philadelphia is about the same; while in Baltimore the rate is about 25 in 1,000, in Boston 26 in 1,000, in Chicago and New York each 27 in 1,000, and in New Orleans 33 in 1,000, according to the latest information at hand. This remarkable salubrity may be ascribed chiefly to the excellence and abundance of the water supply, to the extensive and well-arranged system of sewerage, to the almost entire absence of overcrowding in tenement houses or otherwise (there are but two known tenements in St. Louis, holding together not much more than one hundred families), to the ample width of the streets and alleys in every part of the city, to the vigilance of an efficient board of health and police department, and largely also to the healthy site of the city, which is a broad plateau rising rapidly from the bank of the Mississippi to a level far above high-water mark, thence extending westward in a series of gentle undulations whose ridges are more than a hundred feet above the highest stage of the river floods.

The city is somewhat lozenge-shaped in plan, with a convex river front of about sixteen miles, and a maximum width of seven miles. In the older parts the Philadelphia system of numbering the streets parallel to the river has been followed, but in the newer portions this plan has unfortunately been abandoned.

The amount of building during last year was moderate. The number of permits issued was 2,115; the valuation of the buildings was $3,229,726. These buildings are almost exclusively of brick, though sometimes with fronts of sandstone ashlar on the more expensive houses. The frame buildings are rarely of any consequence, being chiefly sheds, stables, and small additions to brick houses.

St. Louis dwellings are almost invariably arranged on the L plan, the dining-room and kitchen being in a rear building on the same level with the parlors. Basement houses are not popular, and are rarely seen. Wide alleys bisect every block and give convenient access to each house at the rear.

Building materials of all kinds are abundant, cheap, and of good quality. The city rests upon a stratum of excellent brick-clay, often many feet in depth, from which are made the best of ordinary and face brick, perfect in color, shape, and surface. A favorite method of grading down a lot that is too high is to establish a brick-yard on it and convert the surplus material into a marketable commodity before removal. Beneath the clay are inexhaustible beds of white limestone, hard and strong, yet easily worked, and furnishing the best of material for rubble walls and for cut-stone steps, sills, and other details. This stone crops out along the river front and in numerous "sink holes" and other depressions within the city limits. Thus quarries as well as brick-yards are everywhere to be found within convenient reach. The limestone also furnishes the best of lime for mortar, while the Mississippi River benevolently deposits an excellent supply of clean building sand on the bars above and below the city and on the opposite shore. Fire-clay and coal are found beneath the limestone, and both deposits are largely worked. Cement is obtainable from Alton, twenty miles up the river. The Iron Mountain, eighty miles south by rail, supplies iron in quality and quantity to suit any demand; also an excellent red granite closely resembling the well-known Scotch granite, and used in the same way for polished shafts on the exterior of buildings. From the same place come considerable quantities of yellow pine lumber, while white pine is brought down the river on rafts. It has thus the benefit of a thorough water-soaking in transit as an aid to seasoning, with, however, the disadvantage of a consequent loss of brightness and uniformity of color, and a more or less serious discoloration. For this, among other reasons, it has been found difficult to introduce here the custom of finishing interior wood-work in shellac, as is so often done in Eastern cities. Painting and graining are still the universal fashion in St. Louis interiors.

During the past winter rubble masonry foundations have been laid for the extremely low price of $1.75 per perch of twenty-two cubic feet, mortar, labor, and everything else included. Some weeks ago, however, the quarrymen and the leading stone masons formed a combination and advanced the price to $2.50 per perch, which is the nominal rate at present. Bricks are furnished and laid in the wall for $8 per thousand. Plastering is done for about eighteen cents a yard. Floor joists of ordinary sizes are held at $14 per thousand feet; "Star" lumber at about $35 per thousand.

The real estate market is dull, and has been so for the past ten years or more. Good lots within half an hour's ride of the center of business, in an unexceptionable neighborhood, fronting on good streets well paved and sewered, with water and gas, and paved alleys, may be purchased at $25 and upward per front foot. These lots have a depth of 100 to 150 feet or more. A fair six-room brick house can be built for $2,000, and $500 more will suffice to add almost every desirable convenience. Such a house, if well planned and in a good neighborhood, will rent, when new, for $25 to $35 a month, according to locality. Older buildings of the same size can be rented as low as $20 a month in some parts of the city.

In St. Louis, as in nearly all the other cities of this country, except New York and Boston, there is an almost entire absence of houses planned for occupancy by two or more families. The German population have, indeed, for years been in the habit of building what are popularly known as "Dutch houses," two stories high, intended for one family to a floor, the upper floor being reached by outside stairs at the rear; but these houses are quite destitute of the conveniences demanded by American tenants, and are occupied almost exclusively by foreigners. Within a little more than a year or two small but genuine apartment houses have been built. One of them was eagerly taken at remunerative figures as soon as it was done, and the owner of the other is understood to be about to build again, on a much larger scale. It may therefore be assumed that the era of flats has begun in this city, greatly no doubt to the increase of the comfort of its citizens. Whether or not it will equally promote the healthfulness of the city will remain to be seen. —C. E. ILLSLEY, *in American Architect.*

* See Am. Journ. Pharm., May, '58, p. 246—Pharm. Journ., March, '58.
† Journ. de Pharm., March, 1864, p. 459.

COAL OIL DANGERS.

TESTIFYING before the Coroner's jury, at Jersey City, in the inquest on the body of Catharine Foley, who died from injuries caused by the explosion of a kerosene lamp, Prof. Henry B. Cornwall, of Princeton College, said:

I have sent for and examined five samples of oil that caused explosions in different parts of the State; all gave off inflammable vapor below 100 degrees Fahrenheit; one took fire at 85 degrees, one at 99 degrees, one at 105, one at 106, and one at 111, the last being better than what is admitted as standard refined petroleum by the rule of the Produce Exchange. Respecting the two tests applied to kerosene—one called the flashing test indicates the temperature at which the oil yields inflammable vapors; the other, called the burning or fire test, indicates the temperature at which the oil itself takes fire from the ignited vapors. It has been repeatedly shown and proved that the burning test may be ten to thirty degrees higher than the flashing test, and my observations show that oil standing a fire test of 110 degrees will not stand a flashing test of 100 degrees; Dr. Chandler, of New York, gives 86 degrees as the average temperature of the oil in glass lamps which have burned for four hours in a room warmed to 83 degrees; when the room was warmed to 92 degrees the average temperature of the oil was 92½ degrees; the highest temperature in any lamp is 98 degrees; any oil flashing below 100 degrees would be dangerous under such circumstances.

The flashing test is the only safe guide in testing oils; it should not be below 100, which would secure a reasonably safe oil; if a lamp filled with this oil is upset and broken the oil will put out the flame of the wick if it runs over it, or at least will not ignite as a bad oil does at once; out of fourteen oils tested in one small town only four were so safe; at the present price of kerosene in barrels the difference in cost per gallon between a safe oil standing 100 degrees flashing test and an average oil of 110 fire test would be $\frac{28}{100}$ of one cent even if the naphtha removed from the oil were thrown away; it is the naphtha or benzine left in the kerosene in refining, or put in by dealers, which renders it explosive; the explosion is caused by uniting a mixture of the gas from the oil with the air in the lamp; on this account explosions frequently take place by blowing out lamps, air being forced into the lamp; more than half the explosions I have met with have taken place while the lamp was burning quietly; there is less danger in extinguishing the lamp very low, by turning down the wick so that the lamp goes out of itself; the only real safety is in using safe oil; the explosion would probably be more violent if the lamp were nearly empty; in the present case the test fell sixteen degrees below the lowest safe test; a retail dealer can add ten per cent. of benzine to kerosene having a reasonably safe flashing point without making the oil worse than the average oil that I have tested; kerosene is made from petroleum which is refined by distilling; during the process light and very inflammable products known as naphtha and benzine are first driven off, and after they are removed the kerosene begins to come off from the still; if the refiners begin the collection of the kerosene too soon, these naphthas remain in it and cause the inflammable vapors which are so readily ignited.

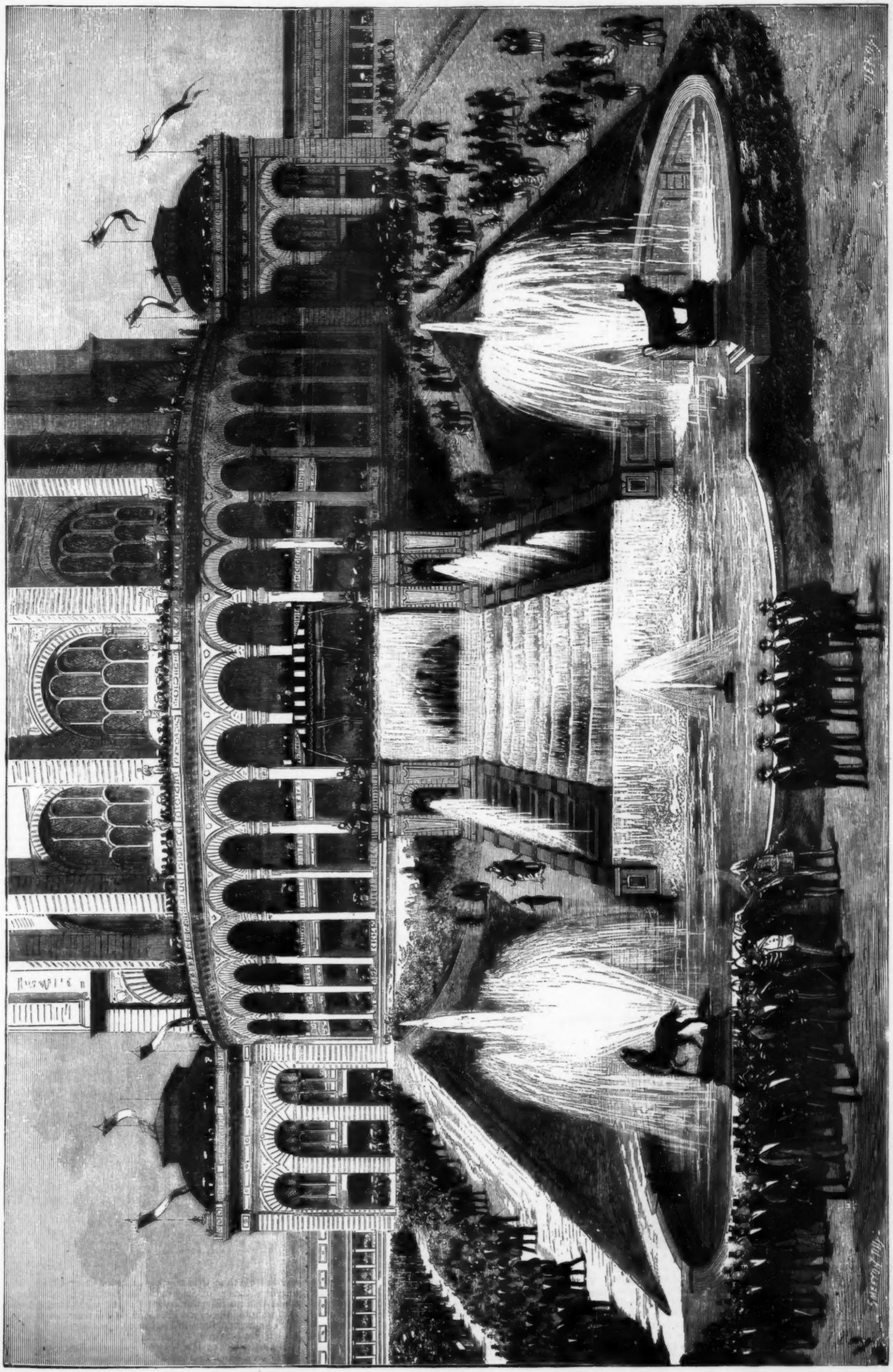
George Sommers, who has been in the kerosene refining business for twenty years, testified that the oil sold in Jersey City is 100 degrees flash, while that sold in Hoboken is 112 degrees flash; did not believe that the peddlers who purchase from him adulterate the oil, as there is very little difference in late years between the prices of the light and he heavy oils.

AMERICAN SILK MANUFACTURE.

AT a recent meeting of the Silk Association of America, in New York, a report was made showing the value of products, classified by articles, manufactured during the past year. The total value was $21,411,436. Of this amount, $1,712,083 was for dress goods; $1,319,081 was for millinery, foulards and silks; $1,324,165 for handkerchiefs; $3,927,496 for ribbons; $2,896,320 for ladies' dress trimmings; $4,126,460 for machine twist; $2,368,485 for trams; $1,353,488 for organseine; $850,000 for spun silk. Other articles produced were fringes, floss, sewing silk, laces, women's and men's scarfs, braids and bindings, and upholstery.

The value of reeled silk consumed was $8,456,341, and of spun silk, $850,000. Besides these there were consumed in sewing and twist, 454,253 pounds, valued at $4,475,958, making a total value of material consumed $12,105,095. According to the report, the silk manufacture, in common with other industries of the country, has passed through a period of comparative inactivity and depression during the past year. A few of the mills have been closed. During the present session of Congress a further element of uncertainty has been introduced by the prospective legislation upon the tariff, which has discouraged enterprise.

SAL. WATER is proposed as an agent for taking ink spots out of cotton goods.



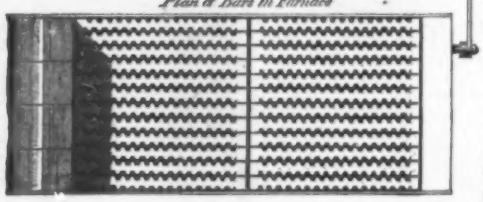
OPENING OF THE PARIS EXHIBITION OF 1878.—THE PROCESSION LEAVING THE PALACE OF THE TROCADERO.

ROCKING FIREBAR.

THE bars are formed with the ordinary deep web with projecting ribs on each side of the bar, so arranged that the projections of one bar are opposite to the spaces of its neighbor. This causes the spaces between the bars to be of a zig-zag pattern, and thus distributes the air much more uniformly into the fire than can be effected with straight bars, and a better and livelier combustion is thus insured. Again, the ribs are not arranged up and down in the depth of the bar, but have a diagonal inclination to meet the direction of the draught. One outside bar at each side of the fireplace is fixed. The others are supported in the usual bearing bars by semi circular ends, so that they are perfectly free to rock as desired. Underneath the firebars there is a rocking cross-bar, into which the bottom of the webs of the bars engage in suitable notches. When, therefore, this lower bar is moved, the firebars are caused to rock or take a diagonal position, as seen in one of the front sections The motion of the agitator is effected by teeth on it gearing into a segmental pinion secured on a longitudinal shaft under the fire-grate at one side of the flue. At the other side is a similar shaft which carries the other end of the agitator on rollers. The longitudinal shaft which carries the pinion is continued out through the front of the furnace, where it is fitted with a suitable lever or handle, by which it may be continuously rocked or moved now and then, as required. The supporting bearings for these longitudinal shafts are fixed to the bearing bars, plates for which are riveted to the sides of the flue as usual. So the whole of this apparatus is self-contained, and can be fixed in any possible description of boiler, marine or otherwise.

Section showing Side View of the Bars.

Plan of Bars in Furnace

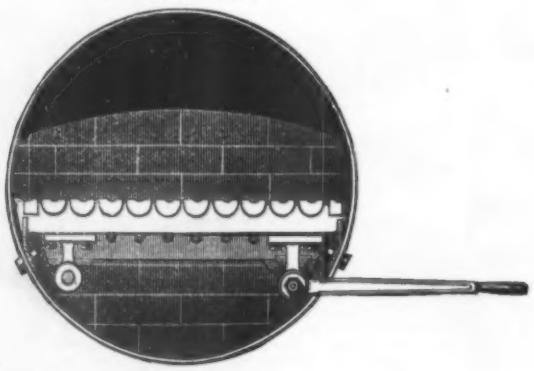


These bars have already been fitted to hundreds of furnaces, we learn, with uniformly satisfactory results. They have been tested with all kinds of fuel, Welsh hard steam coal, nuts, small coal, coke, breeze, and in some cases with small coal and sawdust, or with small coal and tan mixed as 1 to 3; and in large hotels where they have been fixed they burn all the refuse mixed with a small portion of coal. These bars have been proved by measurement of water and weighing of coals to effect a saving in large Cornish boilers of 12½ per cent., and to evaporate 25 per cent. more water. In one large establishment where nearly forty boilers are employed the result is a saving of 35 per cent. in the consumption of coals, which is, in such case, a very large sum. The company, we understand, who make and supply these bars guarantee a minimum saving of 12½ per cent. over the ordinary firebars, and 5 per cent. over any patent bar or arrangement which exists at the present time.

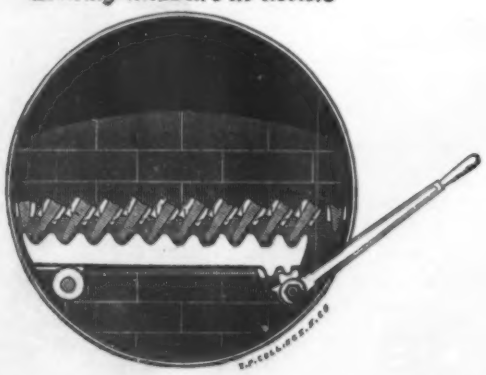
The bars last a much longer time than ordinary bars, owing to there being such a large surface exposed to the air, and for this alone they would commend themselves to the steam user. The rocking of the bar has the effect of lifting the fire from the bars, and thus removing clinkers or almost preventing their formation. The movement has also the effect of rousing the fire, keeping the air-spaces open, and maintaining the fire bright and clear. This is effected without opening the firedoor, which is a distinct advantage compared with the practice of opening a firedoor to prick up a fire. The quantity of air admitted to the fire will be increased by the canting of the firebars, and thereby combustion will be accelerated. By this action, then, the rate of evaporation can be increased as desired, and kept up in any case where a sudden demand for steam may arise. They have proved very successful in steam vessels where slow and quick firing is at times required, and they have been at work in large mills for years, working day and night with great success. Their exceptional command over the draught and evaporation, so that the latter can be increased as desired, has often enabled steam users to use one boiler where two have been necessary.

Irrespective of the advantages which these bars possess in the saving of fuel, they have proved themselves the best of the day in regard to the consumption of smoke, and were awarded a first-class certificate at the recent Manchester Exhibition of Sanitary Appliances. This invention, on the whole, seems one of the most simple and convenient that we have seen for the purpose, and therefore likely to be practically useful.—*Iron.*

Front View.



Section, showing the Bars in action



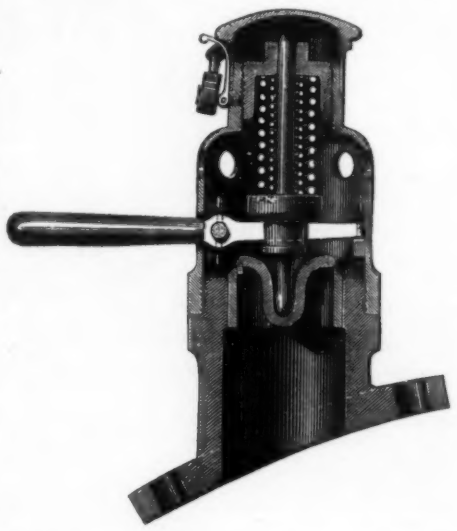
BOILER FEED REGULATOR.

THE engraving shows a neat fitting brought out by Messrs. W. Pope & Son, Edgware-road, London. It is an overflow tap for feed pumps. In using it the suction of the pump is opened to its full extent, and let to remain so; the index of the regulator is shifted toward S until the water level is at the required height; it will now continue at that point. To fill the boiler for night or meal times, some time before stopping the index is put to S. For the usual height the index is put to the number that was found to maintain the water level; a very small movement of the hand will vary this.

LOCK-UP SAFETY-VALVE.

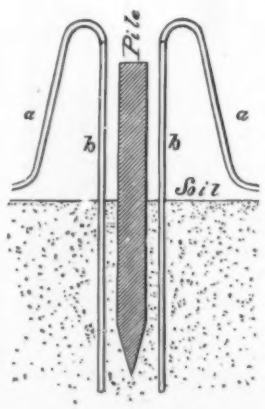
THE subject of boiler safety is now receiving much attention, and it is of an importance to deserve every consideration at the hands of engineers and steam users. The annual reports of the Boiler Assurance Companies serve every year more strongly to mark the fact that explosions may be much mitigated, or even, perhaps, entirely avoided, by due attention to the construction, fitting, and periodical examination of steam boilers.

One of the most important fittings for security on any boiler is a lock-up safety-valve, so designed that pressure can never accumulate in the boiler above the fixed working pressure. This contrivance has also this advantage, that it prevents tampering with the safety-valve, either willfully or accidentally, by the engine-driver or stoker. A lock-up safety-valve, guaranteed to blow off at a certain pressure, no boiler should be without, for it is a certain protection against overloading from any cause. If the ordinary valve is the usual weight-loaded lever-valve, it may stick on its seat, or the ball may be accidentally pushed further from its fulcrum than is suitable for the intended working pressure. Either of these causes may produce overloading to a very considerable extent. In some cases the pressure gauge may be out of order, and the safety-valves may appear to blow off at 40 lbs. per square inch, as indicated on the pressure gauge, instead of at 60 lbs. per square inch, as intended. There is then a possibility that the engine man will be stupid enough to alter the weighting of his valves to indicate 60 lbs. on the gauge before blowing off, when in reality the boiler pressure will be above 80 lbs. A lock-up safety-valve, set and registered to blow off at a certain pressure, is a sure check against such mistakes, and will serve to show the error on the pressure gauge. Messrs. Robey & Co's (London) Patent Lock-up Valve, which we illustrate, is well calculated to fulfill all the necessary requirements. The seat is a brass bush, with a flat valve face designed to permit a little lateral movement in the valve without disturbing the joint. The valve has a hollow recess in the center, upon which the spindle bears as low as possible in the valve. This prevents the possibility of a canting cross strain on the valve wings, such as is often produced by loading pressure on the top of the valve. The spindle is loaded by a double spring, which gives the maximum elasticity of spring load, with the greatest load in the shortest length of spring. The end of the spindle passes through and is supported and guided by an adjusting screw nut, which has the usual hexagon cross at the top for adjustment with an ordinary spanner, and by which the tension of the spring can be accurately set to blow off at a given pressure. As a protection against tampering, the whole valve seat and spindle is inclosed in an ornamental brass case, only perforated with a few holes for escape of steam and for the lever. The adjusting nut at the top is also inclosed by a cap, of which an eye or lug is securely padlocked through a hinged hasp, and cannot therefore be got at except by the holder of the padlock key. A lifting lever is inserted through the case, by which the valve can be lifted from its seat now and then to make sure that it has not corroded or stuck in any way, and a boss is inserted inside the case upon which the end of the lever rests so that it cannot be used to give any downward pressure on the valve. The whole design is of good proportions, and will make a handsome fitting on any boiler.—*Iron.*



NEW SYSTEM OF PILE-DRIVING.

MESSRS. STŒCKLIN & VÉTILLART, during the course of their works in enlarging the harbor of Calais, experienced great difficulty in sinking the piles and plankings through the fine moist sand that forms the beach at that locality. Struck not only by the great expense, but by the large amount of time that the old method necessitated, they sought a means of improving on the latter, inasmuch as speed was an essential element of success. Remembering that water had been used to facilitate the penetration of hollow cast-iron columns in England, its use suggested itself on the present occasion. Pressed for time, and with no means of entering on anything like an elaborate system of experiments on a beach that the tide left exposed but six hours at



a time, they began their trials in a most elementary way. By means of two small garden pumps, each worked by one man, water was forced through rubber hose (*a*, *a*) into two iron tubes (*b*, *b*) placed one on each side of the log to be sunk, with their orifices from eight to twelve inches below the end of the latter. The sand, loosened and held in suspension by the current of water from the pumps, offered thereafter but slight resistance, and the work of sinking the piles over an extent of 1,500 feet progressed with great rapidity and at a much reduced expense.

On the old plan, an average of 185 blows was required to drive a pile, and 900 for a panel, requiring on an average 8 hours and 36 minutes. With the new system of water injection the number of blows per panel varied from 0 to 50, the mean time being only 1 hour and 9 minutes. Many of the panels required only from 14 to 16 minutes.

The extraction of piles or planking that have become broken or displaced, hitherto attended with considerable difficulty, may by the new system be accomplished with great ease.

THE STRENGTH OF WROUGHT IRON.

THE New York *Tribune* says that a series of experiments has been carried on at the Washington Navy Yard, by Commander L. A. Beardslee, of the United States Test Board, to ascertain the strength of iron used in chain cables. It had been suspected, with just reason, that the British Admiralty tables for the strength of wrought iron needed revision. Not less than two thousand tests of the tensile strength of iron have been made at the Navy Yard, to determine the elastic limit, elongation, and reduction of area of the various specimens, and forty-two complete chemical analyses have also been performed. Some of the conclusions which have been reached are remarkable. The Admiralty tables are declared unsafe, and new ones have been prepared. The board finds that the tenacity of two-inch bar for chain cables should be between 48,000 and 52,000 pounds per square inch; one-inch bar, between 53,000 and 57,000; and that stronger irons than these make inferior cables, because they have less ductility and capacity for welding. The strength of wrought iron and its welding power are influenced quite as much by the reduction it has undergone in rolling as by ordinary differences in its chemical composition. In general, the processes for making wrought iron give an uncertain quality to the product, while the methods of making cheap steel confer certainty and uniformity. The ordinary practice of welding is capable of great improvement, by being performed in an atmosphere freed from oxygen. The importance of the subject will be conceded, since the safety of human lives must often depend upon the strength of a ship's cable or of the links in a bridge chain.

THE CREUSOT WORKS EXHIBITS AT PARIS.

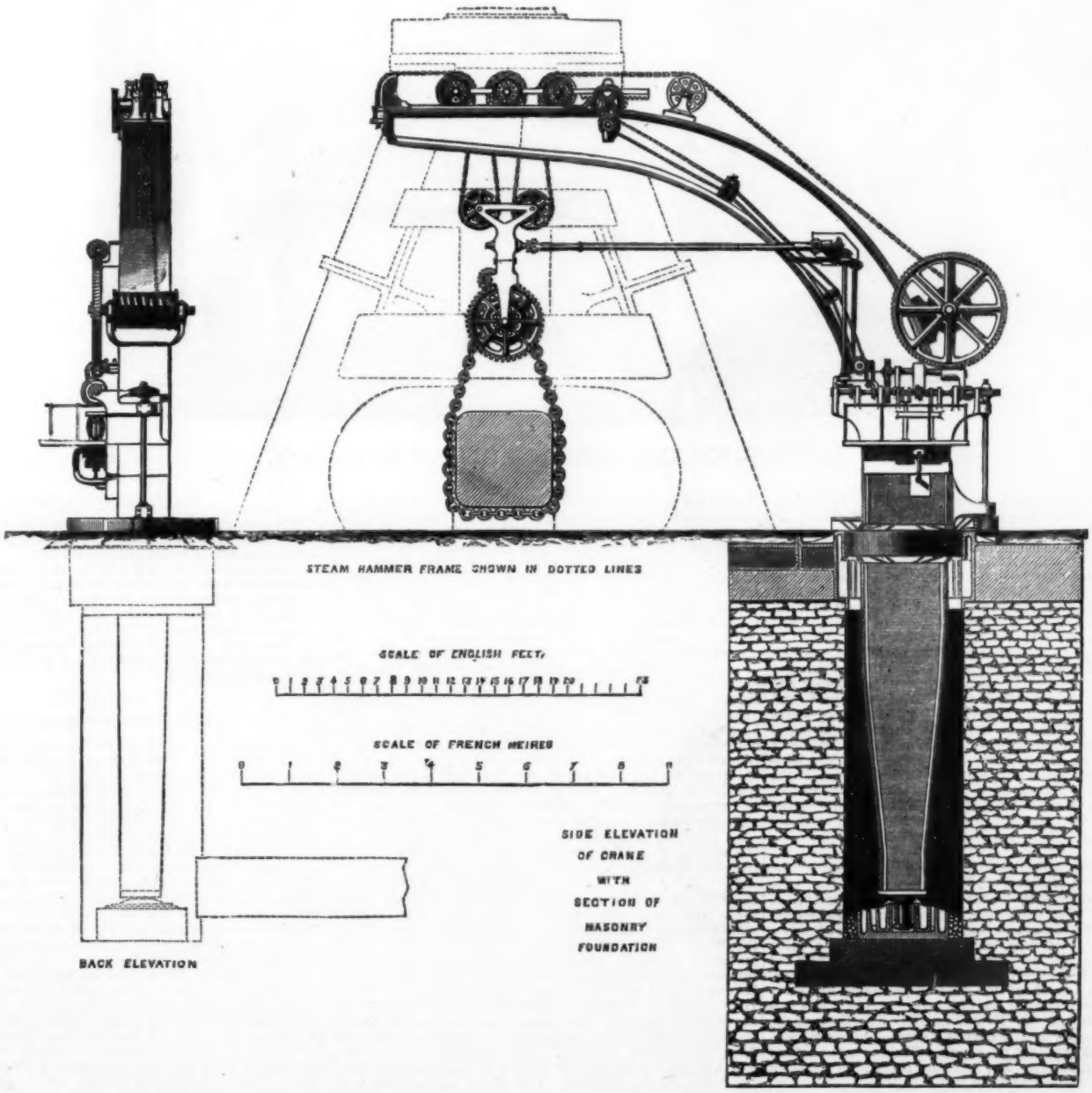
THE exhibits of MM. Schneider et Cie., of Creusot, occupy a large pavilion in the park of the Champ de Mars and comprise raw materials, products, specimens of their manufactures, various statistical and other documents relating to commercial and industrial organization of the works, mines, schools, and workmen's towns. This complete collection has been arranged by M. Henri Schneider, who continues the work of his father under the will of the late M. Eugene Schneider, the creator of the vast establishment at Creusot, and of whom a statue by the eminent sculptor Chapu, cast in bronze by MM. Thibaut et fils, forms an attractive object at the bottom of the pavilion.

The 160-ton cranes are of the revolving post crane class. As will be seen from the engraving, the post and gib are formed in one bent plate girder, supported by a foot-step, and revolving in a ring of friction rollers near the ground surface, and carried by a casting firmly fixed to the masonry well and tied to the foundation plates of the hammer. As all the cranes are thus fixed and tied to the hammer bed plates, the strains due to each are largely balanced, and this assemblage of the whole secures great rigidity. From the pivot to the head each crane is 17·4 meters in height, the height from the footstep to the ground level being 8·4 meters, and from the ground to the head 9 meters. Each crane is capable of four movements by means of the small attached double cylinder steam engines, which, when running at 250 revolutions per minute, develop about 60 horse power. The four movements are: (1) Swinging. (2) Lifting. (3) Traversing. (4) Rotating the load. The three first motions are nothing special; they are given by means of worm, bevel, and spur wheels. The load is suspended from an immense bridle, the sling chain running over a large sheave. The lifting chain passes over a series of wheels arranged to permit the third motion, and is wound upon a helically grooved barrel. The third motion is effected by means of a pitch chain, as will be seen from the illustration. The fourth motion is one of novel application, but one which is absolutely essential in handling large masses. It is that by which the piece being forged is turned over and round upon the anvil, and by its means a hundred tons forging will be turned with facility, while a forging of a few tons at present requires a small army of men for its manipulation. The movement of rotation is, it will be seen, effected by means of a telescopic shaft connected to the engine and to the sheave referred to by means of universal joints, known in this country as Hook's joints, and on the Continent as Cardan's joints, by means of which the shaft may follow the vertical movement of the load, its length altering in accordance with the motion of translation by means of its telescopic form. The total weight of the 100-ton cranes is 110,000 kilogrammes, and of the 160-ton cranes 140,000 kilogrammes. The operator stands on a platform in front of the engine, where he has command of all the levers, by which he carries out the orders of the smith.—*Engineer.*

THE LAND OF MIDIAN AND ITS MINES.

THE recent return of Captain Burton and his party from the Land of Midian at the beginning of this week is already known by telegraph in England. The object of the expedition was to examine into the mineral wealth of the country, which hitherto has been very little visited by travelers, and is only imperfectly known to geographers. Yet the minerals of Midian were known both in biblical and classical times. Everybody remembers how Moses, when he fled from the face of Pharaoh, dwelt in the land of Midian and married the priest's daughter; and how, notwithstanding this alliance, the children of Israel, after the Exodus, vexed by the wiles of the Midianites, made war upon them and slew their kings, and burnt their cities and their goodly castles, and spoiled them of "gold, silver, brass, iron, tin, and lead," and "jewels of gold, chains and bracelets, rings, earrings, and tablets;" and how Moses ordered the wrought jewels of gold to be brought into the Tabernacle as a memorial. It is equally well known, too, how the Romans long afterward again worked the mines whence these metals were dug—and many are the traces of their work which Captain Burton has recently found. Yet next to nothing is now known of the country, its wild wastes of rock, its barren valleys and precipitous mountains, its vast half-worked mines, its ruined cities, and its wandering and savage population. That it lies to the east of the Red Sea, that it belongs, for some mysterious reason, to Egypt, is about all 99 out of every 100 people know about it. Captain Burton's two expeditions will have at least one good result—they will instruct the people. Thanks to his kindness, I am able to give a sketch of his recent doings, and even my summary will prove the land to be at least as interesting as many countries which have long been the happy hunting-field of enterprising travelers of all nationalities.

The expedition left Suez December 10, 1877, and returned there on April 20, 1878. During four months of hard traveling and voyaging upward of 2,500 miles, they only lost one soldier, who died of fever. They brought home some 25 tons of geological specimens to illustrate the general geological formation of the land: six cases of Colorado and Negro ore; five cases of ethnological and anthropological collections—such as Midianite coins, inscriptions in Nabathean and Cufic, remains of worked stones, fragments of smelted metals, glass, and pottery; upward of 200 sketches in oil and water colors, photographs of the chief ruins, including


STEAM HAMMER FRAME SHOWN IN DOTTED LINES
SCALE OF ENGLISH FEET.
SCALE OF FRENCH METRES
SIDE ELEVATION OF CRANE WITH SECTION OF MASONRY FOUNDATION
BACK ELEVATION

THE PARIS EXHIBITION—EXHIBIT OF THE CREUSOT WORKS.—160-TON CRANE.

catacombs, and of a classical temple, apparently of Greek art; and, finally, maps and plans of the whole country, including 32 ruined cities, some of whose names can be restored by consulting Strabo and Ptolemy, besides sketches of many *ateliers* where perambulating bands like the gypsies of ancient and modern times seem to have carried on simple mining operations.

Among the specimens are argentiferous and cupriferous ores from Northern Midian, and auriferous rocks from Southern. There are collections from three turquoise mines—the northern, near Aynuneh, already worked; the southern, near Ziba, still scratched by the Arabs; and the central, until now unknown save to the Bedouins. There are, moreover, three great sulphur beds, the northern and the southern, belonging to the secondary formation (now invaded by the trap granite), and the central, near the port of Mowilah, of pyretic origin. Rock salt accompanies the brimstone, and there are two large natural salt lakes. The whole of the secondary formation supplies fine gypsum, and in parts of it are quarries of alabaster, which served to build the ruins of Maghair, Shećayb, Madiama (of Ptolemy), and El Haurá (Leuke Kome), the southernmost part of western Nabathea.

The term Midian, popularly derived from Medan, the Hebrew, is really the old Egyptian "Mádi," a word which occurs in many papyri, whose plural is Mádian or Mádiná. The modern tribes that hold the land confine "Mádyan" to the strip of maritime country between the coast Ghauts and the sea, from the fort of Allabah (lat. 29 deg. 30 min.) to Mowilah (lat. 27 deg. 32 min.). Captain Burton calls this country Northern Midian, and he applies the term Southern Midian to the tract of about similar size stretching south from Mowilah to the great Wady Hamz (lat. 25 deg. 55 min. 15 sec.), where Egypt ends, and the Hedjaz, the holy land of the Moslems, the capitals of which are Mecca and Medina, begins. He also divides the country into two mineral districts: the northern, with Makná as its port, has not been much worked; the southern, with Wedj as its harbor, shows extensive traces of ancient scientific labor. But he describes the whole as affording great mining capabilities to modern science. These conclusions he arrived at by dividing his four months' explorations into three several excursions—northern, central, and southern.

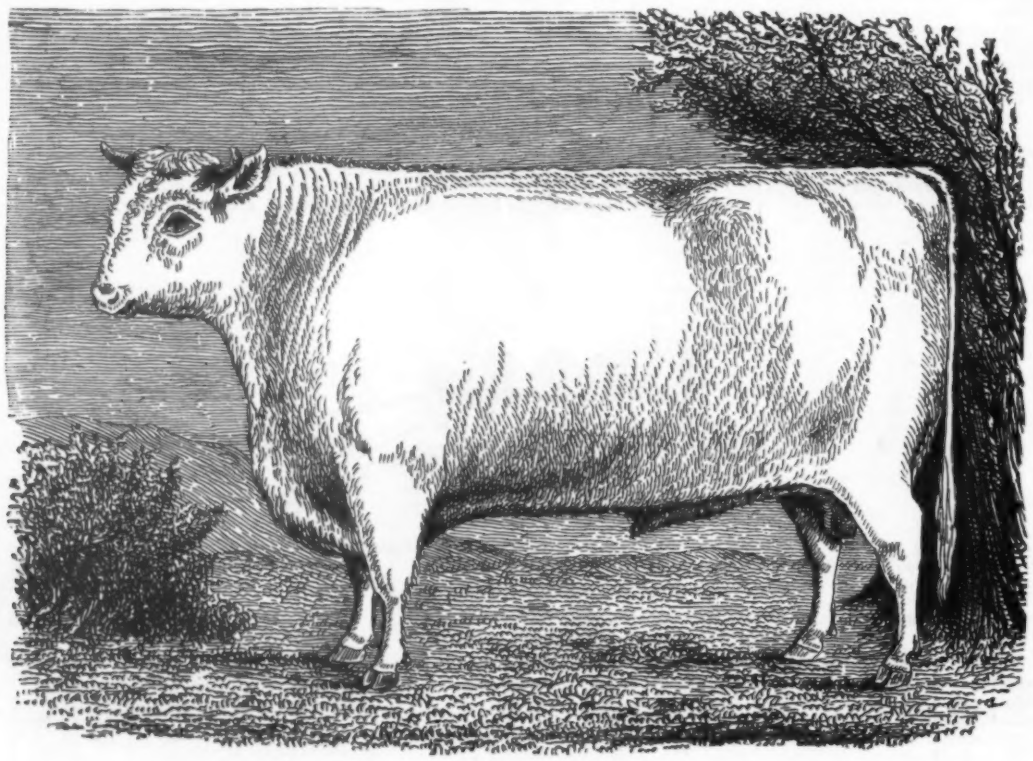
The caravan consisted of eight Europeans, three Egyptian officers of the staff and two of the line, 25 soldiers and 30 miners, 10 mules, and about 100 camels. The northern excursion commenced at Mowilah, the port of arrival in Midian. They revisited the country covered by Captain Burton's expedition last year, the story of which will be told in his forthcoming book, "The Gold Mines of Midian," which I must not anticipate. After reinspection of the ancient workings of the precious metals, passing the traditional site of Moses' Well, they marched upon Makná, the port, and spent a week digging into and extracting the veins of silver which thread the quartz, carelessly cupeled specimens yielding 15 to 20 per cent. of silver. The hill is within a few minutes' walk of the coast, and by means of Mr. Haddan's cheap tramways it would be easy to ship the ore in the harbor. Leaving Makná they rounded the windy Gulf of Allabah, and the incorrectness of the British hydrographic chart very nearly shipwrecked the party on the reefs off the island Tiran. They reached Mowilah again on February 3d.

The second expedition followed and was directed to the inland region east of Mowilah. The object was to determine the longitudinal breadth of the metalliferous country. A double chain of ghauts subtends the coast, and a succession of valleys cuts through these heights. Beyond the ghauts a rough and precipitous pass, terrible for loaded camels, leads to the Hisma, a plateau some 4,000 feet high, of new red sandstone, which is in reality the western wall of the Nejd, or great central uplands of the Arabian peninsula, and is remarkable for the beauty of its brick-red precipices and castellations. East of the Hisma lie the dark lines of the Marreh, the basaltic and doubtless volcanic regions whence the miners of old brought the rough mill-stones that served for their first grindings. But here the expedition reckoned without its hosts, the Maäzeh, a semi-Egyptian tribe, who received them apparently with friendliness, but all the while were preparing for attack, murder, and plunder. The trap, however, was badly set for an old traveler. Captain Burton guessed the coming danger, and was able to beat a hasty retrent without bloodshed. The expedition, altering its plans, then turned to the southeast. They passed through the lovely Wady Daumah, once teeming with fertility, now laid waste by the Bedouins, "the fathers of the desert." They discovered the ruins of the city of Sheewak (the Souka of Ptolemy), which, with its outlying suburbs, its aqueducts carefully built with cement, its barrages across the village heads, its broken catacombs, its furnaces and vast *usines*, covers some four miles. Here and elsewhere the furnaces were carefully searched. The Colorado quartz-ore and the chloritic greenstone, used as flux, showed what ore had been treated; but so painstaking were these old miners that not the minutest trace of metal was left to tell its own tale. Sheewak was evidently a city of workmen, probably of slave workmen. A few miles to the south lay Shaghab, the ruins of which, far superior in site and construction, suggested the residence of the wealthy mine-owners. Here the expedition turned west. The country was barren, roadless, and very thinly inhabited, but they came upon the ruinous traces of mining operations at every stage. March 5 they arrived at the flourishing little port of Ziba (Zibber on the hydrographic chart), built with the remnants of some older town. Near Ziba was found the southernmost of the turquoise mines. Its natives have learned the art of promoting the growth of pearls by inserting a grain of sand into each oyster.

The third, or southern excursion, which Captain Burton was enabled to undertake by the dispatch of a second ship and another month's food from Suez, proved by far the most interesting to mineralogist and archæologist alike. Gold mining evidently here takes the place of silver and copper extracting, and the vast traces of the labors of the scientific old miners in shafting and tunneling teach exactly their *modus operandi*. The Marreh, or volcanic district, which they inspected, extends as far as Yembo, and possibly as far as Medina, the Holy City. It is covered with ruins of mining works, and the expedition found gold threading and filming the basalt, which led them to believe this district to be the focus of the mineralogical outcrop. Meanwhile, M. Marle, the mining engineer, proceeded to the southern depot of sulphur, and discovered a third hill distant only two miles from a navigable bay. He secured specimens of this rock and also of chalcedony, the material of the finely-engraved seals and amulets worked by the natives. He found, and the whole party afterward visited, an outcrop of quartz, in mounds, hillocks, and gigantic reefs, called "Abel Marwah," and the disused works, of great extent, were surveyed. The caravan, now guided by the Balizy tribe, which claims some of the old mining districts, left the port of Wedj, March 23, and visited the ruins of Um el Karayyat ("Mother of Villages"), where the remains of mining operations lie scattered about in all directions. In parts the hill of snowy quartz had been so well burrowed into that it had fallen in. All the shafts and passages were duly explored. The precious metal was extracted from the rose-colored schist veining the quartz and specimens of free gold appeared. The next march showed the Um el Kharáb ("Mother of Desolation"), in which an extensive vein had been worked, and pillars of quartz left standing between roof and floor. Traveling through a land once rich and prosperous as mining could make it, now the very picture of dreary desolation, the travelers reached the plain El Beda (Bedals of Ptolemy). Here the hills of red porphyry were covered with religious inscriptions in the Cufic and modern Arab characters; nothing Nabathean occurred. On April 8, after traversing another quartz country, the expedition reached their Ultima Thule, the Wady Hamz, the great gap worked by water in the maritime mountain chain which forms the highway for pilgrims returning from Medina, and constitutes the frontier between Egypt and the Hedjaz, which belongs to Turkey. Here a pleasant surprise awaited the party. On the southern brink of this wild water course was the site of a beautiful little temple, built of white and variegated alabaster, dug from neighboring quarries. The foundations alone were left, and a few years ago the place was a tumulus into which the Arabs dug for treasure. The Wady had washed away the northern wall, and the adjacent bed was strewn with fragments of columns, bases and capitals, all of alabaster and cut in the simplest and purest style of Greek art. Can this be a vestige of that ill-fated expedition, in which Ælius Gallus was foiled by the traitor Nabathæsus?

This closed the expedition. The party returned to Suez, and arrived in Cairo the 21st of April, 1878. They received a most courteous welcome from his Highness the Khedive. Specimens of their ores will be sent to Paris and London; the rest will be analyzed in Cairo by a local commission, while the curiosities of all kinds will be exhibited first in Cairo and then sent to the Paris Exhibition. So ends the story. After all the allowances made for the traveler's love of the scene of his labors, it must be admitted that the Land of Midian is a wonderful place. As one hears of the mines that are spread over the country, with their shafts and their tunnels, their furnaces and their barrages, the towns of workmen, and the cities of mine owners, one begins to understand why "all King Solomon's drinking vessels were of gold, none were of silver, it was nothing accounted of in the days of Solomon." And when one reads of the mines that are yet unworked, with their quartz and their Colorado ore, one feels tempted to ask why the Khedive at Cairo, like Solomon at Jerusalem, should not "make silver and gold as plenteous as stones." But hitherto brilliant prospects for Egypt have turned out very gray-toned realities. So we Egyptians are content once more to possess our souls in patience until the cool and cautious capitalists of Paris and London put their hands into their pockets, pay the Khedive a handsome royalty, and turn the Land of Midian into a limited liability company. One thing is certain. This dead country of Midian, thus suddenly brought back to life, is no fabulous land, where all the world can go and pick up gold and silver. Its development will need capital as well as science; and Egypt must, therefore, be content with a royalty and leave the risk and the work to foreign skill and enterprise.
—*London Times.*

VEGETABLE IVORY is the name given by its inventor, M. Turpin, to caoutchouc hardened with magnesia.



SHORT-HORNED WHITE BULL "WHITE BOY."

IRISH SHORT-HORNS.

WE give drawings from the *Dublin Farmers' Gazette* of a couple of Irish short-horns that will doubtless be regarded with interest by our agricultural readers.

Short-horned white bull, "White Boy," owned and bred by Richard Chaloner, Kingsfort, Moynalty, County Meath, was awarded the first prize in his section, at the late spring show of the Royal Dublin Society, 44 competitors.

Short-horned roan heifer, "Lady Violet," owned and bred by Mrs. J. S. Pery, Coolcronan House, Foxford, County Mayo, was awarded the first prize in her section at the same show, 10 competitors.

CONCERNING COCOANUTS.

THE cocoanut palm is one of the most useful trees of tropical regions, since all its parts are utilized, though its fruit is the most important product. This palm is seldom found at any considerable distance from the sea coast, except where it has been introduced and cultivated by man, while it generally succeeds best in sandy soils near the sea. It has a large, cylindrical stem, two or three feet in diameter at the base and one foot at the top, and from sixty to one hundred feet in height, with many rings marking the place of former leaves, and bearing at its summit a crown of from sixteen to twenty immense, feather-like leaves, which generally curve downward, and are from twelve to twenty feet long. The flowers cluster around the top of the trunk, inclosed in a sheath, and are succeeded by nuts, ten or twelve of which are usually bunched together.

The cocoanut tree begins to bear fruit in its sixth or seventh year, blossoms about once in six weeks during the rainy season, producing annually eight to twelve bunches, each tree averaging a yearly yield of from eighty to one hundred nuts. In six months from blossoming the nuts which have the kernel begin to solidify, while in a year the fruit is fully ripe, or even sooner if the season is hot and dry. The produce of the tree, in full health and properly tended, is much dependent on soil and climate. While the average in fertile upland soils may be estimated at 120 nuts in the twelve months to a tree, in low and sandy soils the

product will amount to 200, though when planted in gravelly soils the yield will not be over sixty. The most productive months for ripe nuts are from January to June, the heat bringing them quickly to maturity. Trees growing in the most fertile soils will live for a century, others less favored from sixty to eighty years only, the former yielding fruit with rare intervals until their sixtieth year, then gradually decreasing in fruitfulness until decay sets in.

The cocoanut is most important to mankind, whether considered as a delicious nutritious food, or as supplying valuable oil and many other articles useful in social life. The nut, when it is gathered young, contains an opaline water, which is quite clear if filtered, and is utilized for drinking. In countries where palatable water is not obtained, only the milk or water of the cocoanut is drunk, and it forms an agreeable, nutritive and healthy beverage. The pulpy matter when young is easily detached from the shell with a spoon. It is a delicate food, though little appreciated by those whose only acquaintance with the cocoanut extends to eating it after it has ripened, hardened, and become almost horny, though even in this state it is still edible, but indigestible and usually only eaten associated with other food. The inhabitants of tropical climates obtain a great part of their food from the cocoanut, which they not only use as it comes from the tree, both ripe and unripe, but also in various other forms.

The fibrous husk of the cocoanut, or coir, as it is often called, is not its least valuable product, and gives rise to a large trade. Instead of rough cordage and mats, formerly made only by hand, through the use of ingeniously constructed machinery the fiber is now rendered sufficiently fine for the loom, and matting in various designs is produced. Coarser fibers serve to make brooms, baskets, cords, cables and many useful articles. The immense leaves are used for roofing, while the wood itself is valuable for building houses, boats and fences. The kernel contains more than seventy per cent. of fixed oil, which is extracted by various processes for perfumery use, soap, lamps, and, when fresh, for dietetic purposes. The production of fiber and oil is capable of indefinite extension, as there is practically an unlimited demand for both, in America as well as in Europe.

The cocoanut palm is cultivated in great abundance on the Malabar and Coromandel coasts, Ceylon, Straits Settlements and the islands of the Eastern Archipelago. In Madras there are no less than 218,000 acres under cocoanuts. In the West Indies, Central America and Brazil the cocoanut is extensively grown; along the Brazilian coast there are groves of it for about 280 miles. From Para alone 7,500,000 cocoanuts, worth $650,000, are annually shipped to the United States and elsewhere. At Travancore over 6,000,000 trees are growing, while from Cochin more than 6,000 tons of cocoanut oil are exported. British India in 1875 exported over 17,000,000 pounds of coir, yarn and rope made of cocoanut fiber, valued at upward of $675,000. On the island of Ceylon nearly 200,000 acres of land are shaded by cocoa palms, and in 1870 5,478,000 nuts were exported therefrom, while in 1871 2,577,700 gallons of oil, valued at upward of $1,000,000, were exported. In Java and Madeira there are more than 20,000,000 trees. At Tahiti there are 200,000 cocoanut palms, which produced in 1874 more than 12,500,000 nuts. The Friendly Islands in 1863 exported 704 tons of cocoanut oil, worth $105 per ton. In Jamaica, within the last few years, 18,500 cocoanut palms have been planted. At Trinidad over 4,500,000 cocoanut palms have been planted. At Trinidad over 4,500,000 cocoanuts were shipped in 1876. Cocoanuts can be had at Trinidad at $10 to $13 per 1,000; in Jamaica they sell at $18, and in Central America at $25 per 1,000.—*Boston Cultivator.*

THE SEED TRADE.

By ANDREW J. LAWSON.

THE trade in field and garden seeds is about over for the season. We learn from one of the principal dealers in seeds that the demand for various embryo or matured ovule this season has been larger than for some years. No doubt the dull times and the small margin for profits has prompted farmers and others to grow a much larger breadth of land than usual of those seeds which bring forth fruits that tend to human sustenance. The fact that everybody is practicing more or less economy in their household and business affairs is one of the incentives to a more liberal seed-planting. Mother earth is the providence, under certain conditions, that comes to the relief of man when the ordinary artificial agents of life fail to accomplish their ends. "And God said, let the earth bring forth grass, the herb yielding seed, and the fruit-tree yielding after his kind, whose seed is in itself."

The seed trade of Boston is largely located in the immediate vicinity of Quincy and Faneuil Hall markets, and is confined to about half a dozen houses, one of which was established over half a century ago. At that period the waters of the harbor ebbed and flowed within a stone's throw of this old seed store. In those days one concern was sufficient to supply the northern New England demand. A single house at the present time sells more seed in one season than was sold by all the seed stores in New England fifty or sixty years ago. One reason for this is because gardening has become a specialty within the past ten or fifteen years. Half a century ago nobody thought of raising early cucumbers, lettuce, asparagus, etc., for market. These things were planted in the old-fashioned way, at the old-fashioned time of the year. Amateur gardening is also more prevalent than it used to be. The overgrowth of Boston, and the consequent building up of a country life within city limits, the erection of numerous large towns within a radius of ten or fifteen miles of the city, has created a demand for certain lines of seeds that were only limitedly called for some years ago. Now, every well-regulated resident of Boston's suburbs has a garden patch of his own, and in some cases several acres are devoted to the raising of vegetables as well as fine fruit and berries, the plant-bugs, insects and other pests of the agriculturist and horticulturist to the contrary notwithstanding. The markets of Boston, at certain seasons of the year, attest the rapid growth of the seed trade, while the general statistics on the subject are eloquent with results of the rapid growth of the trade.

The first regular seed store in Boston was located in an old building on the spot where the head of Quincy Market now stands, and was kept by Willis & Newhall, the pioneers in the business. After it was resolved by the town authorities to build a market after the plans of Mr. Quincy, the firm went into the building on Market Square, opposite the north side of Faneuil Hall, now occupied by the Messrs. Breck, who are, in fact, the successors of the pioneer firm, having been in the trade ever since. The firm of Willis & Newhall was succeeded by that of Willis & Chamberlain, and that, in turn, by the Breck family, the senior Breck having come to Boston from the town of Pepperell, Mass., where he had been engaged in the flower-seed trade on a limited scale. The next firm to go into the seed business was that of Ruggles, Nourse & Mason, now succeeded by Ames Plow Company. The principal seed business of Boston is now in the hands of a few very reliable and enterprising firms, the leading dealers being Schlegel, Everett & Co., Parker & Gannett, Whittemore Bros., Joseph Breck & Sons. James J. H. Gregory, of Marblehead, is also one of the most enterprising and reliable dealers in this section.

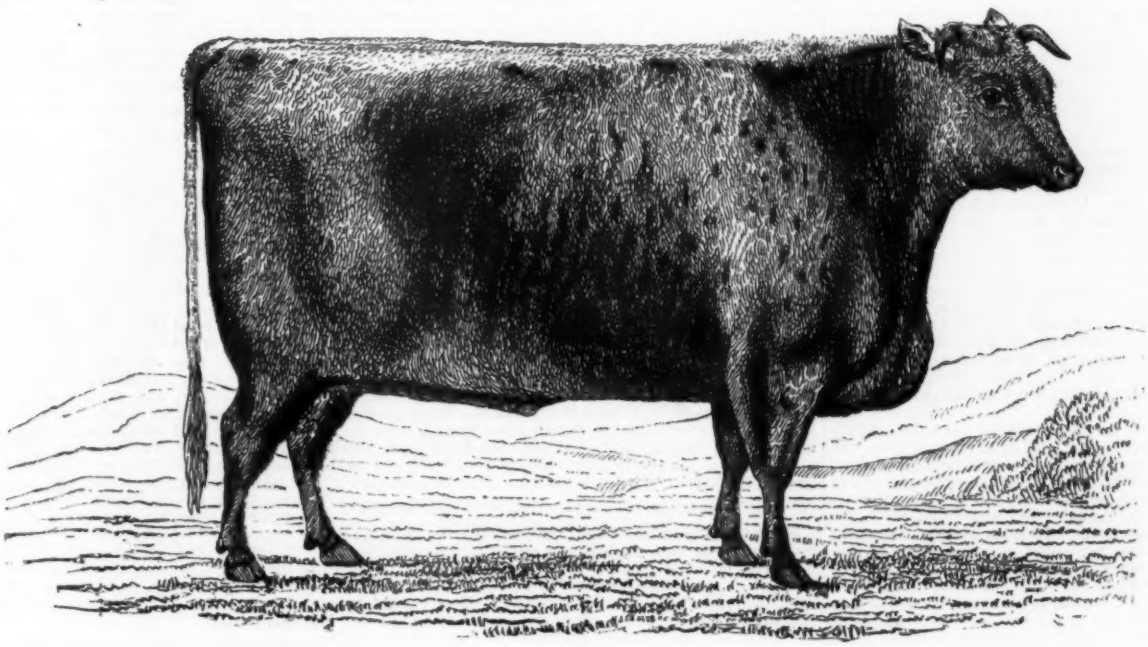
The capital invested in the seed trade of the country is very large, and great care and patience are involved in the raising of good seed for the general distribution.

Of late years, or since the establishment of the Agricultural Department at Washington, there has been a marked improvement in the quality of certain lines of seeds, besides the introduction of new kinds that have proved beneficial to the country. There has been a disposition in some quarters to regard these department seeds as worthless, but there is abundant evidence to the contrary. Since 1870 the department has distributed something like 4,400,000 packages of seeds, including many varieties of a most practical character. This distribution has been principally made through members of Congress, statistical correspondents, meteorological observers, State and county agricultural and horticultural societies, and farmers' clubs, reporting regularly to the department. Fully two-thirds of the seeds distributed by the department include vegetables, cereals, textiles, seeds for field culture, and tree seeds. Two-thirds of the whole number of seeds distributed by the department represent vegetables.

The cost of seed distribution is now less than fifty cents for each thousand of the people, and there is reliable evidence that a single specimen of grain distributed in a single State has realized, in enhanced production, ten times the amount expended for all seeds sent to all the States in that year. The international courtesies inaugurated and fostered by a system of mutual exchanges of the products of the soil are prolific of most valuable results. Following the successful introduction of American seeds into foreign countries, especially those in which the modern systems of agriculture prevail, inquiries continue to come regarding the best modes of culture, the introduction of improved machinery for the husbanding and utilizing of crops, and questions of similar import, thus extending the benefits of our improved mechanism and labor-saving farm and garden implements.

The seed operations of the Department of Agriculture in 1876 were on an immense scale, embracing a million and a half packages. Of the total number of these 337 varieties were of vegetables, and of these 893,974 packages were distributed, or more than one-half of the entire quantity of seed distributed; and of field seeds nearly 300,000 packages of quarts and half pints were given away. The cost to the government for the putting up of seed has been reduced from $7,000 to $5,000 a year. Quart bags in which the seed used to be put up cost about $24.70 a thousand, including material and all the labor of putting up the seed. The paper box now in use more or less costs about $8.20 per thousand. A patent machine for making the paper seed box cost the government $5,000. The cost of running the government Department of Agriculture is about $275,000 a year, which is cheap, indeed, compared with the efforts of the State of Massachusetts to run a State agricultural college which has shown no practical results from its maintenance. Considering the amount of money that has been expended on this so-called agricultural college, the government Department of Agriculture, in view of the great and practical work it is accomplishing, would be cheap to the people at an expense of $5,000,000 annually.

A writer somewhere estimates the net value of the products derived from a given quantity of wheat seed in the proportion of five dollars to one dollar expended. However correct or inaccurate the conclusion, it is obvious that planted seed is about the best capital a man can have. Nature is his chief helper, and an unfailing market his buyer. Gossip about seed and the seed trade is suggestive of normal and market values. The attribute of normal or usual value implies systematic and continuous production, while supply and demand outside the market are among the conditions which determine price within the market. The influence of demand and supply on the price-current in a given market is exercised through the opinions of dealers in that market. And this is a matter which never fails to address itself to the farmer or gardener when he puts his seed into the ground, for be it known that "extractive" industry has an advantage over any other industry, for the reason that the products of the soil, brought to market, permit a much wider margin of deviation for the market from the nominal price. The shortest



SHORT-HORNED HEIFER "LADY VIOLET."

period within which additions can be made to the supply of food and raw material of the vegetable kind is, in general, a year, and if the commodity be of animal origin the minimum period is considerably larger; and although the farmer may vary the breadth of ground to be devoted to a particular crop, the actual returns will vary according to the season, and may prove far in excess or far in defect of his calculations; and these circumstances tend to produce deviations of the market, and give the farmer a decided advantage, in many cases, over those who deal in mills and machinery, whose commodities, produced in excess, often fall below the level of nominal price. Of all producers, the planter of seed experiences the results of "quick sales" and fair profits to an extent more enjoyed than by any other class of workers. A handful of wheat seed will produce enough flour for a single meal. The artisan who produces a handful of sawdust is, however, a benefactor in his way.

No doubt the free disposition of seeds on the part of the government has done much toward developing some sections of the country. The first seed brought from the Old World by the Pilgrims was ill-adapted to the soil and climate of New England. The only grain which the people of New England had cultivated in 1631 was Indian corn. Before the introduction of mills it was coarsely pounded. "The want of English grain, wheat, rye and barley," says an old writer, "proved a sore affliction to some stomachs, who could not live upon Indian bread and water, yet they were compelled to it." In reference to the first sample of rye produced, it was observed: "This poor people greatly rejoiced to see the land would bear it." Within ten years, wheat became an article of export for Massachusetts.—*Boston Cultivator.*

PEACH GARDENS OF FRANCE.

AMONG other curious facts observable in the peach gardens of France is that the trees grafted on the plum stock ripen their fruit at least a week or ten days earlier than the same variety grafted on a free peach stock, and this early development of the fruit is further enhanced by placing sheets of blackened paper on the whitewashed walls behind the fruit.

THE INTERIOR OF THE EARTH.*

SIR GEORGE AIRY remarked that the nature of the subject was different from any upon which he ever lectured before, in regard to its indefiniteness and to the difficulty he should have if he considered it to be his duty to lead them definitely up to some point. He could only give them some idea of the theory to which he wished to lead them, and in doing so he would advert collaterally to a good many points which might be valuable. He proposed to divide his address into three parts. The first would relate to the measures of the earth; the second to observations on temperature; and the third to the manner in which they might suppose the earth to have been formed, especially with regard to the nebular hypothesis; and after that he would add some remarks on the conclusions to which these lead.

TRIANGULATION.

He described the process called triangulation, by which a large part of the contour of the globe is covered, and by which it is possible to lay down a map on which the distance between any one point and any other point is ascertained to within a few inches; how this was valuable in ascertaining the dimensions and figure of the earth with the aid of the zenith sector, an instrument for measuring the apparent distances of stars from the point overhead. He showed on a large globe the principal lines of measurement which had up to this time been made for this purpose.

DIMENSIONS AND FORM OF THE EARTH.

From these measurements, there was no doubt that the earth is very nearly a sphere of 8,000 miles in diameter, or 25,000 miles in circumference. When he spoke of the surface of the earth, it must be understood that he spoke of the sea-level. Above that level stand mountains, and below are the depths of the sea. But although these inequalities of surface are taken into consideration by those who go accurately into calculations, they are comparatively very small. Suppose he were to make a sphere twenty-five feet in diameter, representing the earth, how much did they think the mountains would rise above the level? One-fifth of an inch. Well, of course that never could be seen; and it was a thing that in all ordinary calculations might be neglected. So that they might say that the earth was a sphere, with an exception he would mention presently.

VARIABLE DENSITY OF THE EARTH.

Then there was another thing which was important to their present subject, and that was the density of the matter of which the earth is formed; and this was a matter which had engaged the best experimenters in two or three ways. The first of the experiments of this kind is a very celebrated one known as the Schihallien experiment, so called from its being an experiment on a mountain in the Scottish Highlands (Perthshire) particularly adapted to these measurements, which are most favorably carried on in the north and south direction. It was found that the mountain Schihallien disturbed the plumb-line, causing a deviation from the vertical of 11″ or 12″. Then if that mountain, whose dimensions we can measure, turns the plumb-line so far, what is the proportion of its attracting mass to the attracting mass of the earth? And as we know the size of the mountain and the size of the earth, we can compare the density of the mountain and that of the earth. This process was gone through with great care, and it was found that, taking the density of the mountain as we could trace it by its constituent rocks, the density of the earth would be about four and a half times that of water, or about twice the average density of the surface rocks. The earth had density everywhere, but was more dense toward the center than the outside.

The next experiment is known as the Cavendish experiment. Here was a very light rod of deal, six feet long, suspended by a fine copper or silver wire (which is the most delicate suspension we can have) forty inches long, within a wooden case to defend it from currents of air. At each end of the lever was hung a ball two inches in diameter, and by a simple contrivance a pair of leaden spheres, weighing together perhaps 300 lbs., were brought simultaneously into the neighborhood of the balls (but outside the case), on opposite sides, so that they might attract the small balls; and the experiment was varied until, by a series of calculations, the density of the earth was ascertained, and gave a greater result than before, namely, that the average density of the earth was about 5½ times that of water.

Then the third experiment was one which he made himself in the Harton colliery, near South Shields. That was by seeing how much the force of gravity was altered by going to a great depth, the force of gravity being ascertained and compared at the top and bottom by the swinging of a pendulum. From that a calculation was made, and it gave the density of the earth as six times that of water. He believed the best calculation was that founded upon the Cavendish experiment, and was quite willing to take something like 5½ times the density of water as the average density of the earth, including every part of it.

THE TREMENDOUS PRESSURE AT THE EARTH'S CENTRE.

There were consequences which followed from that which were certainly very striking. As this density was rather more than double that of the surface rocks, it showed that toward the center the earth was more condensed than at the outside. But there was one result of the calculation which rather startled him when he made his own experiment on the subject. Since these rocks press upon each other more and more the further you go down, what is the pressure upon the square inch when you approach the center of the earth? Many gentlemen there would have heard of a pressure of 50 lbs. or 100 lbs. on the square inch, and perhaps the greatest pressure we know is that by which tough Aberdeen granite is crushed—10,000 lbs. to the square inch. But it must be 30,000,000 lbs. to the square inch in the center of the earth; and it is an astounding thing to imagine what consequences may follow. We have no idea of any such degree of pressure, and cannot therefore conceive what its consequences may be. Perhaps thereby gas may be squeezed into gold or platinum, and powder to solid, or solid to powder—we cannot tell what it does. That enormous pressure, and our total ignorance of it, is one of the difficulties and troubles of this case. He thought the general state of the earth would be understood from what he had said, and now he came to the rotation of the earth.

THE ROTATION OF THE EARTH.

The earth revolves, as everybody knows, in the course of a day; and everybody knows also, from the housemaid who whirls her mop to the greatest philosopher, that rotation will swell out the middle of the earth. Calculations have been made upon that, and the result is that the diameter of the earth in the equatorial direction is greater by about 1-300th part than the diameter in the polar direction. When they found that the measurement of the dimensions of the earth agreed so well with that conclusion, it led them to the further conclusion that the earth is, or has been, in a fluid state.

FLUID CONDITION OF THE EARTH.

In corroboration of this, he would mention a singular circumstance which occurred in our Indian Survey. In proceeding northward from Cape Comorin, the curvature of the earth agreed very well for many hundreds of miles with that found in other parts of the earth (with due reference to the elliptic form of the earth). On approaching the Himalaya Mountains, the plumb-line was sensibly attracted by the mountains. The late Archdeacon Pratt investigated, from the form of the mountains and the density of the rocks, the disturbance of the plumb-line, and found that it ought to be much greater than it really is. Sir George explained this by supposing that the whole of that country is floating upon a dense fluid, and that the thick mass of the lighter mountain-matter sinks deep in the fluid, and that the displacement of denser matter neutralizes almost entirely the attraction of the lofty mountains. The form of the earth is not such as would be taken by a solid structure, but such as would be taken by a fluid mass with solids floating upon it.

THE HEAT OF THE EARTH.

In the second part of his address, Sir George Airy referred to what is known about the temperatures. They knew something of the rate at which temperature travels through the earth. The experiments on this point had begun, as many good experiments have begun, with the French, who fixed thermometers with very long stalks to the depth of twenty-five feet in the ground. These experiments were followed up, after some time, with similar thermometers, at the Observatory at Edinburgh, and about the same time at the Observatory at Greenwich, and there the deeper thermometers were read every day. The first and most conspicuous result of these experiments is the retardation of the seasons. At the depth of twenty-five feet, high midsummer heat occurs at December, which shows that it takes five months for the heat to travel down that depth. If you compute it further, it takes 100 years to travel a mile; so that if the crust of the earth is 100 miles thick, it will take 10,000 years for the transmission of heat through it. This showed that really, after all, we may have a great deal of heat below us, and that it will not come to us for a very long time. It will come at last, but it will come traveling up slowly, and in the meantime the radiation from the surface of the earth will carry it off very rapidly. So that it is quite possible that with a cool surface there may be a great deal of heat below. In every part of the earth there is evidence of intense heat in former times.

VOLCANIC ACTION EVERYWHERE.

The extent of volcanic action is partly lost on the earth by the effects of air and water; but when they looked at the old rocks, they found there had been volcanic action almost everywhere. In our limestone-rocks, for instance, there are the basaltic veins, which in some parts go by the name of toadstone, which are certainly the result of volcanic heat enough to produce fluidity. Almost everywhere they found that there were volcanic streams intermixing with all the rocks; and even although the surface of the earth had been free from volcanoes in a given district for a time, yet there had always been volcanic action very near, enough to force in veins of lava from time to time. It seems, therefore, that we are entitled to say that we have always been near a great deal of heat—probably we have been much nearer it than at the present time, but still we are near enough to experience a great deal even in these countries.

HEAT INCREASES AS WE DESCEND INTO THE EARTH.

Repeated experiments have been made on the increase of temperature as you go down in mines, and the conclusion has been come to that the temperature rises one degree Fahrenheit sometimes in sixty and sometimes in 100 feet. There is a mine in Cornwall in which he had walked in a stream of water at the bottom actually scalding to the legs! and everybody knows what quantities of water there are in the hot springs. And then there is the great display of the volcanoes, which come from a great deal of heat somewhere; and in places where volcanoes are extinct we can trace a sort of basaltic continent, so to speak, up to the very mouths of the craters from which the lava has come. So that there has been in all former ages undoubtedly much more heat than at present.

CHANGES IN THE EARTH'S MAGNETISM.

There was another matter on which he would desire to speak, but with no great boldness, and that was the change in magnetism. The subject of terrestrial magnetism is one of the most obscure in the world; nevertheless, looking at the direction in which it always is toward the colder parts, and tracing its general phenomena, it may be effected by thermo-electricity, and that may be produced by the constant wear going on in the interior of the earth, where the fluid lavas are consolidating themselves. Within a few years the voyage of the Challenger has been made, and he had little hesitation in saying it was one of the most important in the scientific history of the world. In crossing the great seas they sounded to great depths, and measured in a satisfactory way the temperature of the water down to the depth of five miles. They always came to cold at the bottom; and there are great controversies whether the cold can come in deep sea streams from the frozen regions of the north. He thought that had some influence; but he thought the bottom of the water and the ground at those great depths is cold—he did not think that part of the earth partakes of the same heat as other parts; that he only expressed as his opinion, in which, of course, he might be met by the disbelief of a great many persons. That was the state of things as we know it regarding the temperature of the earth—that there is evidence everywhere that there has been enormous heat almost all over the earth. Some parts of the crust of the earth under the deepest seas are still perforated by volcanic islands. In some places the heat comes very near the surface. That he looked upon as an important fact, leading them to a theory of what the state of the earth really is.

HOW THE EARTH WAS FORMED.

On entering upon a matter which was undoubtedly one of the boldest speculations in modern science, which was the formation of the earth—he could not say its creation, but the way it got into its present shape—he had to premise that the theory on which he had to speak, which is known as the nebular hypothesis, is the conception of a very bold and vigorous intellect indeed. Laplace it was who remarked that all the planets and satellites revolved in the same direction round the sun, and all of them turned on their axis in the same direction: and it was difficult to deny that there must be some general cause for this. It naturally occurred to Laplace that if we can find something which is contracting its dimensions, and which has a little rotation to begin with, then with every contraction of dimensions that rotation would become more rapid, till it might go to any degree, depending upon the condensation of its various parts and its density before.

CURIOUS CHARACTERISTICS OF NEBULÆ.

Then can we come to look at any matter which is being thus condensed, and which might so form systems such as ours, with sun, planets, and satellites? There are a series of bodies in the sky which did not attract much attention in former days, mainly because telescopes were not so large, but which are now catalogued by thousands. These are the nebulæ. The name denotes their cloudy appearance. They are small bodies among the stars, sometimes appearing to have stars in them, or to be connected with stars, and sometimes not. They have the strangest and most capricious shapes imaginable. If this nebula is contracting its parts together so as to form a world, that rotation in the course of condensation will become so rapid that it may form suns and planets and earths around it; and on this supposition there is no difficulty in making a complete solar system out of such a mass as that of the nebula in Orion.

Observations made lately by the largest telescopes—those of Lassell and Lord Rosse, both of which are remarkable telescopes of the largest class—have brought to light a number of nebulæ possessing a spiral appearance; and they seem to have some bearing on the supposition that the nebulæ are contracting and getting into a rotatory state. But these changes go on so slowly that they had not been able to answer with certainty for any of the changes of which he now spoke. The whole thing is theoretical, and yet, as it seemed to him, in the highest degree probable. Supposing this to be the case, these nebulæ would rotate, and in their compression would get very hot.

HEAT FROM THE CONDENSATION OF NEBULÆ.

There is no doubt that condensation would produce enormous heat, and it seems we have there sufficient explanation of the great heat we find below the surface of the earth and in other places. We suppose that the stars generally have been formed from the condensation of nebulæ; and there is a circumstance which was worthy mentioning.

WHAT THE SPECTROSCOPE HAS REVEALED.

A series of observations founded upon optical experiments has come to light within late years which has done more to reveal the secrets of nature than anything before—this was by means of the spectroscope. By voltaic action sparks may be produced which derive their character—sparks like those of an electrical machine—in a great measure from the metals from which they spring. A spark springs from metal to metal, and the character of the metals gives different characters to the sparks. We have one set of these spectra produced by iron, another by nickel, others even by hydrogen gas, and so on, and these are observed and catalogued with great care. When we come to observe the light in the stars in the same manner, we find there are no two stars alike; some of them have the same spectra as that given from iron, and others have spectra from a number of different things; and we are actually able, by legitimate reasoning from this, to say from what the stars are made—what metals and other things they are made of—and, as a general thing, there are no two stars alike. So that in this nebular hypothesis we are not bound to say that the nebulæ are all of the same materials, and we conceive that by comparing the bodies which we know in the solar system with those of the stars, we may arrive at an idea of the variety of materials of which the planets are composed.

We cannot find anything different in comparing the light of the planets, because they all derive their light from the sun, and they do not present any difference of appearance in the spectrum. But we can draw conclusions from their relative density.

COMPARATIVE DENSITY OF THE EARTH, SUN, AND PLANETS.

As he had said to them, the average density of the earth is probably five and a half times that of water. They knew that the sun is only once that of water. What the sun is he could not tell, but it is a very poor light creature indeed. The density of Mercury is perhaps rather greater than that of the earth. The density of Venus is much the same as that of the earth, and the density of Mars is also much the same as that of the earth. Then after that comes a shower of little planets, about 200 of which have been observed up to the present time, and he could not tell what they are made of. Then there are Jupiter and Saturn, which are no heavier than water. So that it appears clear that, assuming the formation of these things by the condensation of nebulæ, on the theory he had mentioned, the different parts of the nebulæ which have contributed to the solar system are very different.

Well, that being considered as established, it follows that in the constitution of our earth there may be parts of very different density. He should say that the high and prominent parts of the land are made of something light, and the heavy and dense parts are those covered by a considerable quantity of water, which have sunk deep into the central lava on which, he conceived, all things are resting.

AN IDEAL SECTIONAL REPRESENTATION OF THE EARTH.

And now he had come pretty nearly to the end of his theory, and he would show them what he feared they would call an absurd representation of what he conceived the state of the earth to be. [The lecturer drew attention to a diagram of an "ideal earth," roughly showing his theory—some parts of the crust of the earth being thick and colored darkly to indicate density; some thick and not so dense, and all admitting of volcanic eruptions from the interior, which was represented as lava.] Remember that everything here is exaggerated. It is not intended to be a correct representation. It is a caricature of the most extravagant kind; but if it conveyed to them the broad ideas that had impressed themselves upon his mind, it would be doing the right thing. He thought a large proportion of the center of the earth is fluid and hot, and he thought that upon this there were certain divers classes of something like solid matter. In all these parts there are cracks or chinks through which volcanoes burst out where the cover of the earth is very thin. In some places you have two or three volcanoes together. There is one instance in Europe, where we have

* Abstract of Address at the Cumberland Association for the Advancement of Literature and Science, by Sir George B. Airy, K.C.B., F.R.S., Astronomer-Royal. Revised by the author.

Etna, Stromboli, and Vesuvius. In this diagram he had condensed to the best of his conjectural power his supposition as to what the state of the earth really is; and if any one chose to find fault with it he would not quarrel with him. He only gave it as a sort of inference from a number of things he had said.

VESUVIUS AND THE SURROUNDING COUNTRY.

(Visited March 10th–19th, 1876.)

By PROF. C. E. CROSBY, Kansas City, Mo.

ONE hundred and twenty-five miles southeast of Rome stretches Campagna, bounded on the north by the Pontine marshes, on the south by the mountains of Calabria, on the east by the foot-hills of the Apennines, and on the west by a translucent sea. Upon this level plain are two objects of interest which will claim our attention: one, Vesuvius, a low, solitary mountain by the sea, bounding from a handsome shore to the height of 4,257 feet; the other, a tract of country nearly five miles square and ten miles distant from the volcano. It will be convenient to first consider the general history and character of the latter.

Setting out afoot from Naples (pop. 415,000), a city of the greatest wealth, poverty and population in Southern Italy, one fails not to notice the peculiar soil, the strange color and the stranger texture of the rocks along his way. No sooner is this brown tufa rock seen—a specimen of which is upon the table before you—than his mind, seeking its origin, wanders far back into the unwritten past, when the Mediterranean not only covered the place of his observation but spread away eastward until it washed the feet of the snow-capped Apennines. In that distant age the back-bone of Italy was unbroken from the Alps to Sicily, but this country, so full of scientific as well as historic interest, was then only a back-bone. While surveying the evidences in silence, he images Vesuvius convulsively rising from the temperate Cænozoic sea, tens of thousands of years before the mysterious Sibylline books were carried from Cumæ, whose ruins are almost indistinguishable before him. He knows this tufa to be only the sediment of the red-hot cinder-shower that poured from that early Vesuvius. During the same epoch the site of the imperial city lay under the tepid sea, whose waters were blackened with the volcanic shower from the neighboring Alban and Cimmian hills. In subsequent centuries the Roman Campagna, with its rich beds of puzzuolane earth—which alone gave durability to the famous Roman cement—and the Campagna about Naples were raised into the sunlight. This account of the formation of tufa becomes more probable, knowing that Signor Guiscardi has collected from the tufa hills of Pausillipo more than a hundred species of shells, but a few of which differ from those now inhabiting the waters that lave the adjacent shores.

That you might better understand the form of Vesuvius and the character of the surrounding country, I have prepared, at a considerable expense of time, a plaster of Paris model of them for a radius of nearly twelve miles. [Prepared from a map by Prof. Phillips, of Oxford, in connection with my own observations.] For the present you will observe this tract, called by the early poets the Phlægrean Fields, lying just west of Naples, and literally covered with craters, varying from fifty to five hundred feet in height. Under the varied influences of bright sunshine, fierce internal heat, drenching rain, a balmy air, and a destructive vegatation, they have descended to us in all stages of perfection, from those whose outlines are barely traceable to those of perfect crateral form, and all are extinct but one. I wonder that so interesting a country is not better known.

Here is Monte Nuovo, 456 feet high, an eruption of 1538 and the last upon record in this part of the Campagna. Its sides are covered with scoriæ and blocks of trachyte, and its oval interior is but nineteen feet above the sea. This is Monte Barbaro, celebrated by Juvenal for its excellent wines. Its crater is a mile in diameter and its sides are covered with a vegetation of myrtle, arbutus and wild evergreen, but the activities that raised it are so remote as to span the whole reach of human history. To the north of these are the striking forms of Monte Grillo, Fossa Lupara, and others, but their paroxysms are buried in the deep past. I can only mention Astroni, whose crater is three and a half miles in circumference, around which are discovered only volcanic ashes and mud; its splendid form and interior vertical cliffs unmistakably indicate that where now "the wild boar and wary deer roam amid forests of oak and ilex, slaking their thirst in small lakes half covered with water lilies," was formerly the place of great volcanic disturbance, which, although unseen, is none the less certain. Furthest to the north is the Piano di Quarto, the longer axis of whose crater is but a little less than four miles.

A little back of Naples is the Pianura, which, although smaller than the last, yet dwarfs that of the present Vesuvius almost to insignificance. I have said that, with a single exception, these craters are extinct, still in many places throughout the Phlægrean Fields the stranger fails not to discover heat that is not "latent" and volcanic products that are not ancient. From hundreds of crevices long thin streams of steam, perceptibly hot, constantly pour from the ominous depths from which are deposited beautiful incrustations of sulphur and the deeply contrasted red arsenic sulphide.

I must call your attention to this crater, the Lago di Agnano, for not only did it attract the notice of the ancients, but throughout the long night of the Middle Ages it was an object of curious superstition. It is not a lake, as its name would indicate, as twenty-five years ago it was drained by an Italian engineer, and now, within its tree-clad cliffs, it presents but little else than a beautiful meadow where graze many flocks of sheep. Within the crater, on the eastern side, the infamous Tiberius built his royal palace by a mineral spring, whose temperature to-day is 180° and nauseous with hydrogen sulphide, while near these ruins, in the crannies of the rocks a few yards away, pure sulphur is being deposited.

But the point of greatest interest is the *Grotto del Cane* (Grotto of the dog), noticed 1800 years ago by Pliny in his scientific writings, and not less full of meaning for us. Before leaving Naples I provided myself with waxen strings, not knowing that the grotto was in charge of an Italian, who asks all he can get for allowing a person to examine it. I can do no better than transcribe my journal. The cavern, located in the side of the crater, is four feet wide and ten feet high, the floor rapidly inclining from the entrance. The rocks are quite warm, but endurable, and one's feet are soon damp with perspiration. When the door was opened, I noticed a white smoke a foot deep pouring out into the plain (crater)—probably the vapor of water. Advancing a couple of steps into the grotto and lowering the taper to my knees, it was instantly extinguished. With a flambeau of hemp I advanced still further in the grotto, then, upon lowering it until immersed into the stream of suffocating gas, it was extinguished as quickly as if plunged into a stream of water. Relighting and going still further into the cave, upon lowering it it was again put out at the height of my shoulder—thus proving that I was standing shoulder deep in the carbonic acid stream which for twenty centuries has been pouring its floods of death out upon the floor of the great crater. Knowing its ultimate effect upon life, I wished to ascertain how a smaller quantity would affect a person. Telling the keeper that I wished to breathe it, he followed me into the grotto. Burying my head in the invisible gas without breathing it, I felt no peculiar sensation, and upon taking a small draught of it into my lungs, I noticed only that the air was a little "close." I then tried two deep inspirations, which produced a roaring in my ears and a dull, boozy feeling in my head, neither of which were painful. Although my vision was perfect, my eyes felt dull and the eyelids heavy. Expelling the gas from my lungs, it was difficult for a minute or two to feel any satisfaction from breathing the fresh open air. I was not satisfied, still I did not think it prudent to experiment further. The Italian's jolly wife said that a dog would become insensible in a minute and a half—consideration one franc. While holding the watch, the dog was lowered into the stream. In thirty-five seconds its eyes rolled wildly and I ordered it out. Recovering quickly in the fresh air, it was again lowered into the gas, and in fifty-five seconds the animal reeled, but he would not take it out as I ordered, leaving it until it fell, one minute and ten seconds after its immersion. When taken out and laid upon the grass, its body was limber and its eyes were closed. In one minute snuffing and choking commenced, followed by awkward efforts to regain its feet. Soon it moped slowly away and was again capering with its companions on the lawn. The fact is these dogs have been killed so many times for the benefit of travelers that they seem to enjoy it.

There is but one explanation of this phenomenon; deep down in the earth's bosom the internal fires warm and decompose the limestones driving off this river of carbonic acid. Eleven twenty-fifths of weight of common limestone is this invisible and irrespirable gas, or forty-four pounds in every one hundred pounds of rock. The amount of gas thus expelled from the deep subterranean rocks, consequently, the amount of rock chemically and physically changed since the superficial observations of Pliny were made must be enormous. Thus we have an explanation of the Guevo Upas in Java, or Valley of Poison, a half mile in circumference. It is an extinct crater, strewn with the "carcasses of tigers, deer, birds, and bones of men," caused by the constant flow of carbonic gas into it. It is no wonder that the crater, Lago Aguano, when filled with water, and, as during the Middle Ages, probably covered with carbonic acid gas, should have been the source of much superstition. With still greater force was this true when neither the existence nor the properties of the gas were known, when philosophy was empty theory, and a rigid investigation of facts, which alone determines their principles, a thought that had not taken hold of the minds of men; and to-day not a few delude themselves in vain efforts to grapple with some of the great scientific questions, absolutely if not professedly ignorant of the simplest details and elementary principles upon which they are claimed to rest.

The craters of the Phlægrean district have consumed much of our time, but I would not omit the most interesting—the Solfatara. It is especially interesting from the fact that from it has flowed the only stream of lava known to the west of Naples. This crater is an elliptical basin of several hundred acres, bounded by walls one hundred and twenty-five feet high. A path leads across the center to the opposite side, many rods of which echo to the walk as if great subterranean chambers were beneath. The guide picked up a thirty pound bowlder and threw it down at my feet, causing the ground to tremble and producing a rumbling not a little startling. Not only under the brier thicket and in the shade of the arbutus was the surface perceptibly warm, but I found several places whose heat could not be endured. Throughout the crater the rocky walls are streaked with yellow, brown, red and white, while the soft floor, mingled with gray and white, abounds with the sulphates of alumina, lime and magnesia. Warned at his entrance, yet he is almost unprepared to witness the strange sight which now meets his eye at the further end of the crater. Not only does steam, scalding hot, issue from a low, narrow cavern, but the roar of its expulsion is so great that near it conversation even in a high tone is impossible. For a minute great volumes pour from the small cavern in torrents, succeeded by short intervals of comparative rest, during which I heard familiar sounds like those of steam escaping from a semi-fluid substance as heard in boiling corn-mush. The rocks within reach are too hot to be handled, and they are uniformly incrusted with bright yellow sulphur and beautiful realgar—the latter by no means plentiful. Stooping low and vigorously using the fifteen foot pole to obtain some specimens, one is apt to venture too far and is liable to get the blast of steam and irrespirable vapors full in his face. Upon the cooled specimens I could distinctly taste alum, and salt upon many of them. Who can work out the complicated reactions taking place in the laboratory below? Leaving, it is impossible not to turn and look at it again, and it is probable that we now view it with the same mingled feelings of admiration and wonder as were experienced by Strabo (30 B. C.) and his contemporaries. Upon the eastern side hollow sounds are heard beneath the feet, and hundreds of small steam vents attest the existence of great energies not far below. Searching for specimens one frequently burns his fingers, and in not a few places is it too hot for shoes. The story is authentic and the geologic evidences are unmistakable; eight hundred and eighty years ago the Solfatara was an active volcano; flame and cinders poured upward in torrents, while the air for miles around was laden with impalpable dust through which hurtled the lightning's glare, and a stream of lava flowed a mile toward the sea. The small artificial opening ten feet deep near the center of the crater is of no little interest. From the soft plaster-like mud escapes the hot steam with a heavy thud, not unlike that heard when a wagon wheel is drawn from the gutter. This escape is periodical, causing a great splash and producing an insufferable odor, much like that of sulphureted hydrogen. One has abundant opportunity to look down into it, and at the proper time he fails not to use an opportunity to get out of its reach. It is strange that this crater, within a stone's throw of the old Appian and public highway, has not been thoroughly examined; were it in the United States the people would have it all excavated in two weeks, and upon the third would have a nice current of red hot lava flowing into the bay; but these filthy, lazy, intensely religious and ragged Italians take no interest in the matter whatever. Upon analysis of these vapors by Dr. Danberry, of Oxford, he found chlorhydric acid, ammonium chloride, hydrogen sulphide and aqueous vapor, but there seems to be no agreement as to the exact kind of chemical relations which produce them. The citations of ancient authors, tabulated by Prof. Phillips, render it probable that twenty and more centuries ago the Phlægrean Fields were in the same mingled state of activity and repose; and, considering the little interest in the various subjects of natural history, it is no wonder that their philosophy should contemplate in this tract "ominous lakes, hot springs and sulphurous vapors," significant only of conflicts between the giants and gods. I will only mention that this model reminds us of that volcanic tract on the upper "horn" of the half moon whose craters are numerous and whose dimensions are surprising.

Here is Monte Nuovo, at whose base lies Cumæ, the most ancient of the Greek cities of Italy, and the Lucrine and Avernian lakes. This eruption of the sixteenth century effected many changes in the geography of the district, as villas were overwhelmed, the area of Lucrine lake diminished by one-half, the town of Tripergola blown into the air, and every vestige of the wharves of Agrippa were destroyed. Preceding its elevation twenty-seven earthquakes shook the Campagna, an additional two hundred feet of the shore were raised into the warm sunlight, but the miserable and starving poor continued to gather the stranded and struggling life. Soon the volcanic fires broke forth; the heavens were darkened with ashes and cinders; lightnings rent the all but universal gloom and shook the air, and the inhabitants of Puzzuoli, affrighted and petitioning their saints, commenced their wild flight toward Naples, whose palaces, five miles from the eruption, were befouled with the descending mud. At its western base Lake Avernus, nearly circular and surrounded by high steep ridges covered with evergreens and oak trees, seems a deep hollow scooped out of the hills, and were it not for two hundred feet of water its crateral form and origin could not have been mistaken. Lucretius' story that in his time the lake was dark and gloomy and that birds attempting to skim its surface would fall dead by the noxious gases, is not at all improbable when we remember the neighboring Grotto del Cane. It would be difficult to select a more pleasing sight than Avernus, above whose dark unruffled waters sea birds gayly skim the surface beneath an azure dome. At about this point, midway between the two lakes on the right, was the cavernous entrance to the Infernal Regions, where answers were returned by the dead, to which Ulysses came, while in the immediate neighborhood was the abode of the Cimmerians. Of this place did the early poet write—

> "Dark was the cavern, wide its jaws of rock
> By the black lake, and woods of mighty shade."

Not all this is poetic fancy, for the cavern is still there, extending several thousand feet beneath the hills, believed by some unpoetic people to have been only a public road to Cumæ. In a bluff by the sea, a mile beyond the Lucrine lake, are the baths of Nero. Many yards can one penetrate this dark cavern until the steam, scalding with heat, not only stops his progress but again reminds him that the great stores of heat are beneath. Further to the south are the shores of Baiæ, along which stretched some of the splendid temples and palaces of the ancient world. Strange does it seem within the roofless temple of Venus, whose walls, once of the rarest marble, yet tower to a height of seventy feet, and whose pavement was costly mosaic, to see old broken down wagons and hear the ring of the blacksmith's anvil! Further are the ruins of Bauli, where Nero planned the death of his mother, the rocky Cape Misenum and the Elysian Fields.

On the north shore of the Bay of Baiæ is the ancient town of Pozzuoli. It was here (Puteoli) that St. Paul tarried for seven days, and the more than matricide emperor practiced upon the stage. I cannot now describe the ancient amphitheater and the other many things of scientific and historical interest, except to notice the old bath house of the Romans—called in more dignified language the Temple of Jupiter Serapis, from a statue found among its ruins. You must imagine an open area—one hundred and fifteen by one hundred and thirty-four feet—on a level with and near by the seashore, strewn with slabs of porphyry, portions of granite and marble pillars with their ruined capitals, the whole surrounded by forty-two compartments, only a few of which are well preserved. Not far from the center of this area are three erect pillars of marble, whose plinth is under water and whose entablature has long been wanting. Its surface is thickly studded with the perforations of lithodomous shells—some of which will admit the little finger—to a height of twenty-three feet. Since its exhumation in the eighteenth century this structure has engaged such scientific minds as Professors Forbes and Babbage, the poet Goethe and Sir Charles Lyell, whose combined researches result in the following conclusions: First, the adjoining Bay of Baiæ during the last eighteen centuries has been undergoing a double movement of depression and elevation. Second, this vertical movement has been so gradual as to escape observation. Third, the pillars were bored by mollusks when they were beneath the sea. Many observations along the coast confirm the view that, during the centuries of the past, the country has been rising and falling like the movements of human respiration. It is claimed by a high authority that there is abundant evidence of its having descended two feet within the past hundred and twenty-five years, at which continuous rate the Phlægrean Fields and Campagna may again be submerged hundreds of feet beneath the victorious sea. Evidently there was a time when these waters did not cover so much country, for beneath the bay is an old Roman road connecting Pozzuoli and Baiæ. I must only mention the volcanic islands of Procida and Ischia, lying just outside of Cape Misenum, which were settled by the Greeks at a time antedating our own era by many centuries, but finally abandoned by them on account of the great eruptions. Again they were colonized by Hiero, King of Syracuse (B. C. 380), but a fortress having been constructed the volcanic fires were again rekindled, when the Greeks abandoned them forever. The last eruption known was in (1302) the fourteenth century, and to-day these rich islands, supporting a population of fifty thousand souls, abound with thermal springs, sulphurous fumes, steaming vents and extinct craters.

Let us study the country to the east of Naples. For thirty centuries have Chalcidensians, Oscans, Samnites, Romans, Normans, and Italians successfully hovered about the rich Vesuvian slopes, made the Campagna a fruitful garden, filled it with prosperous villages, adorned it with splendid palaces and temples and paved it with excellent roads. To-day, immediately around its thirty mile base, are eighty thousand people, cultivating the soil, clipping the vine, gathering the oil and singing their erotic music in the very clouds of Vesuvian vapor. A description of the physical structure of this volcano is not a little difficult, but this

model will give you at a glance an idea of its form and surroundings. Allow me to condense its history. Far back in the past, beyond the furthest reach of written history, Vesuvius was a solitary cone rising out of the Campagna by the seaside. In the war of the Romans against the Samnites (fourth century B. C.), when the former sailed up the Sarno, which skirts the eastern base of the mountain, they beheld upon its slopes a luxuriant vegetation, and afar toward the crater the vineyards bore their loads of fruit, above which low green shrubs and tangled briers nearly concealed the true character of the underlying soil. An epigram by Martial reads—

"Here verdant vines o'erspread Vesuvius' sides;
The generous grape here poured her purple tides."

To this place came the Thracian gladiator (B. C. 73) with his brave comrades, having escaped from their bondage at Capua to the northwest. Ascending the mountains by means of bushes twisted together, they lowered themselves into the well-grassed crater. Neither historian nor poet has left a suspicion of smoldering activities beneath the mountain, and not until A. D. 63 did the dense population become aware of the mighty energies beneath them. Then the earthquakes made great openings in the Campagna, destroyed hundreds of sheep, split many statues, killed many people, drove many insane, leveled not a few palaces and laid the historic city of Pompeii in ruins. The sixteen following years passed away with occasional warnings, until the 24th of August, A. D. 79, when a little after mid-day a tree-like column of black smoke poured from the crater for the first time in the annals of history—the world knows the rest. Before the sun had half reached the horizon, midnight darkness prevailed. For eight days lightnings flashed through the universal gloom and torrents of rain fell from the condensing clouds; suffocating fumes poured from a thousand crevices; cinders, ashes, lapilli and mud showered upon the Campagna, burying five cities beneath the liquid mass. Not until recently have the topographical changes effected by that eruption been carefully determined. More than three thousand feet of the upper part of the cone were blown into the air, and of the remainder that half toward the sea was torn from its foundation to within sixteen hundred and fifty feet of its base, burying beneath the debris the towns of Oplontia, Teglanum, Stabiæ and the considerable cities of Herculaneum and Pompeii. Contrary to what has generally been supposed, neither the surface configuration nor the few accounts of it sustain the view that lava flowed at that time, and for upward of a thousand years (A. D. 1036) the flow of melted rock was unknown to the inhabitants of Campagna.

What is the present condition of Vesuvius? On sixty-five different occasions has lava flowed from the volcano during the last eighteen hundred years, and more than half of these within the past two hundred and forty years. Among the more important changes is the superposition of a new cone upon the shattered old one, but not sufficiently large to completely take the place occupied by the old one; the result is an open space called the atrium, one-half to three fourths of a mile wide and three miles long, between the new cone and that part of the old one—called Monte Somma—not destroyed in the first century. So, too, on the side toward the sea the external surface of the new cone is not even with the old base, thus leaving a circular horizontal plane—the Pedimentina—many rods wide and sixteen hundred feet above the sea.

Ascending Vesuvius from the south side one takes great delight in selecting points of interest and admiring the magnificent prospect spread out below him. Eight miles due west of the crater is Naples with its ragged half a million, and from it to Torre del Annunziata, a distance of ten miles along the coast, is a continuous village street, over which the great black cone towers threateningly. Southwest of the volcano, at its base by the seashore, is Herculaneum, buried from seventy to one hundred and twelve feet beneath the present village of Resina by six different streams of lava, and in the same straight line are the thriving towns of Portici, Torre del Greco and Annunziata. Just five miles away to the southeast is the walled city of Pompeii, whose hundred and sixty-one acres, silent beneath its twenty-four feet of ashes and cinders, are but one third exhumed. Within the limits of history no lava stream has ever reached this celebrated city, although it rests upon an old leucitic current. Near it is the river Sarno, taking its rise in the mountains of Calabria, and a mile to the southeast is the buried city of Stabiæ, where the naturalist Pliny lost his life. From the rocky Cape Misenum, where he had charge of the Roman fleet, he crossed the Bay of Naples to this place, where he was suffocated with the sulphurous fumes—his route being indicated upon the plan. Beneath its load of volcanic cinders excavations have furnished numerous papyri, statues and architectural designs, and the present town of Castelamare, above its ruins, is still famous for its carbonated and chalybeated waters. On the western slopes of Vesuvius and nearly half way to the summit is the observatory founded by Melloni in 1844. It is a fine two story structure, built of lava and located upon a projection from the Pedimentina, at an altitude of two thousand feet. At present it is under the directorship of Prof. Palmieri, and is well equipped with self-registering instruments, the principal object being to record the phenomena that "precede, co-exist with and follow the eruption."

By various instrumental means the direction, intensity, and continuance of the earth movements are recorded with the utmost accuracy and certainty. Long does one gaze from the Pedimentina down upon the Bay of Naples, which, more like an inland sea, washes the feet of the fiery monarch with a liquid azure indescribably soft and beautiful. To the right is Naples, beyond which, upon the hills of Pausilippo, repose the bones of Virgil, the great master of hexameter, whose song beginning—

"Tityre, tu patulæ recubans sub tegmine fagi,"

the world will not soon forget. Still further are the Phlægrean Fields, and forty-six villages of the Campagna, covered with areas of light and shadow that move as noiselessly as the dream of a poet. Southward is Capri with the sinking palaces of Tiberius (erected A. D. 37) covered with and surrounded by the rocky walls of nature's own imperial masonry. Spreading level away with an uninterrupted sweep, and bounded on the southwest by volcanic Ischia and its companion isle Procida, the splendid waters disappear in the open sea. Westward rise rugged mountains, and their beautiful coast is none other than that of Meta and Sorrento extending arrow-like under a dome of lapis lazuli.

Upon this relief I have attempted to represent the streams of the seventeenth, eighteenth, and nineteenth centuries, four eruptions belonging to the seventeenth, twenty-three to the eighteenth, and twenty-five, thus far, to the nineteenth. So startling is the impression experienced when viewing for the first time these varied and desolate streams, that he who has read the theory and has afterward become practically acquainted with the details of any department of science well knows the crushing weight of an argument derived from the latter source compared with that of the former. The mental state effected by the study of an *object* is separated by a wide gulf from that condition of mind produced by studying what some one says about it. There is no mistake; literature, history, and mathematics for their acquirement require the exercise of fewer intellectual faculties than those of the natural sciences. Worthless is the opinion of that individual, in these latter departments, the development of whose powers of sense—perception—has not kept full pace with that of the judgment and reason. Speaking generally, the streams of the seventeenth century have flowed from the south side of Vesuvius, entering the sea in twelve distinct channels. One of the most memorable eruptions occurred in 1631, after rumblings and earthquakes of six months' duration, when the lava broke forth and poured down the southwestern slopes in seven grand cascades of fire and mud, destroying a part of Torre del Greco, burning Resina to the ground, boiling multitudes of fish along the shore, and destroying many thousand people. So frequent have been these hot mud streams that they are often more dreaded than the currents of lava. You will notice that the flows of the eighteenth century have bursted not only from the southern side but from the eastern and western as well, here and there overlapping those of the previous century, but reaching the bay in only a single mouth. Among the more prominent of these is the eruption of 1794, at which time the glowing rock poured down the slopes with a solid front twelve to fifteen hundred feet wide, through the streets and alleys of Torre del Greco, destroying four hundred lives and forcing its way more than three hundred feet into the sea. During the present century eruptions have been more numerous than at any other. Not only do they cover the Pedimentina, but from the crater they have flowed in every direction, but reaching the sea in two distinct channels a half mile apart. But the most remarkable stream for length is that which poured out of the atrium toward Naples, in a condition not greatly unlike fluid iron, reaching a point six miles from its source—the longest stream known in its history since the eruption of A. D. 79.

It is ten minutes past twelve while I sit upon one of the loftiest points of Monte Somma. The deep and desolate atrium is far below, while tremendous volumes of steam roll upward from a crater (seven hundred and fifty yards) nearly a half mile in diameter. No language can describe this sight; it is almost terrifying. At first I stepped behind some rocks, involuntarily breathing full and irregularly with an oppressive feeling I have never elsewhere experienced. The tiresome ascent of Somma having been completed, I expected to look across a narrow gulf upon a smokestack, but through the driving clouds I saw a naked cone higher than the point upon which I stood, black as the darkness of midnight, and while exhibiting no signs of life it was all life. Expecting to witness but a mass of steam as from a caldron of boiling sap, I was filled with silent astonishment before the mountainous billows of fleecy vapors rolling slowly, majestically toward the skies, then swept sharply away by the driving winds. Somma, ascended for security, seemed but a toy above an energy capable of dashing it to atoms upon the surrounding plain. The precipice abounds with ragged projecting rocks of lava, fiery and variously colored, while its shelvings are filled with scoriæ and volcanic sand. For eighteen hundred years has Somma stood unchanged between the hot rain shot from the reddened throat of Vesuvius, while floods of liquid rock poured down through the atrium. Many dikes are visible while making the descent, their dimensions being from a few inches to twelve feet wide and from a few feet to five hundred in height, reminding one how inconceivable must be the forces that can thus split a mountain and fill the openings with melted rock.

Having made the dangerous descent into the great gulf which separates Somma from the cone, I thought of the Lachine Rapids of the St. Lawrence, just above Montreal. Were they instantly frozen, preserving their billowy surface, they would but poorly represent this dark, desolate, and forbidding place. These now cold but once fiery floods remind one of shapeless masses of mud, with this difference, that the former are sharp, hard, and extremely rough, while their masses, an inch to ten feet in height, are so intolerably ragged that one is in constant danger of spraining his ankles or cutting his hands by little falls. Were a thick dough of cornmeal rapidly stirred, then quickly dried so hard that it would ring under the hammer, in some respects it would simulate a lava current. A striking feature of the current is that, while flowing upon a level surface, instead of spreading out like water, it erects its own boundary walls by the rapid cooling of its sides. It is said by observers of the living current that the slowest river of a plain moves faster than a lava current upon a considerable slope. Issuing from the volcano its temperature is about 2,000°, but at a distance the cake-like and curled masses indicate the molasses-like character of the fluid. The scoriaceous and jagged surface abundantly testifies to the slatic pressure of the fluid and the exhalation of its contained gases. One fails not to notice the few bowlders of various dimensions, several inches to three feet in diameter, from brown to bright yellow, covered with a slaggy matrix, but broken open, presenting a pleasing and attractive relief upon the somber, lifeless waste about them. Are these volcanic bombs, once torn from the strata beneath the mountain, shot from the great crater and shattered by the fall? Along the course of a current it would seem that its motion was frequently arrested for a moment, where it would heap, forming a bag or pocket ten feet in height, subsequently parting upon one or both sides, through which break the lava would pursue its destructive course. Continually is one stopping to examine these bag-like masses, botryoidal surfaces, tabular areas, curvilinear forms, and strange prominences which occasionally assume some of the most fantastic outlines, and which would afford secure retreats for animals as large as the cat and dog. With great interest does one trace a single stream from the atrium down the gentle slopes, through cultivated gardens, fruitful vineyards, orchards of olives and the golden fruit. Before you are many specimens of lava collected both from Vesuvius and the giant Etna. At the close of the evening you will have no difficulty in knowing those which were knocked from the surface of the current, as they are rough and deeply cracked, while those specimens which came from the body of the current, not in contact with the air when in a melted state, are dense in structure, while their rounded cavities will indicate the position of the cells which imprisoned the gases. This light, cylindrical specimen was evidently a bomb which came from the upper cone. Little or no pumice is found about Vesuvius, this piece and the most of our commercial article being obtained from Stromboli, whose fires have never for a moment been quenched since the earliest recorded history.

An analysis of lava shows its general composition to be a silicate of alumina, combined with iron protoxide, potash, soda, and lime. But the lavas of different centuries, if they do not differ in chemical composition, certainly vary in their physical properties. It is not a little striking, while walking over these lava fields, to see a stream, cold, naked, and forbidding as when it flowed a century ago, while another beside it, that flowed half a century later, is covered with a crumbled powdered surface, where atmospheric vapor and the rock moss have thoroughly prepared the way for the growing vine. In many specimens you will discover crystals of leucite, olivine, and sodalite, but these perfect crystals of pyroxene I collected from Monte Rossi, an eruptive cone upon the southern flanks of Etna. This single specimen of dolomite is found in considerable quantities about Monte Somma, but is wanting in the lavas of Vesuvius. If, as mineralogists tell us, obsidian is formed by a rapid cooling of lava, it is difficult to understand why none is found here, for the conditions of its formation would not seem to be wanting. This handsome specimen inclosed in its gray matrix is owned in this city by Mr. Wilhite, who found it in Oregon of our own country. Many persons would call it a lump of dark glass. No single locality of the earth's surface has furnished so many simple minerals as the lavas of Vesuvius, and it can no longer be doubted that their manufacture in the great laboratory of nature is far from an extinct process. Here Haüy, the founder of our system of crystallography, picked up no less than eighty simple minerals, but among these no native metals have ever been found.

From the uneven crater of this volcano destruction and death have poured for centuries. Different was the scene twenty-one and a half centuries ago, when the Roman fleet under Regulus made its way to Carthage. Then the checkered vineyards extended far toward the summit, and the wild boar hid among the thickets of the crater. Now it is full of cloud-like steam of fleecy whiteness, which rolls to a great height when it is swept by a stiff breeze over the suffocated dead of its old victim, Pompeii. At no time is it possible to see across the great crater, so dense and continuous is the steam. Occasionally I saw its vertical walls, tinged with red, yellow, and brown, and the shelvings of the rocks are heaped with black volcanic cinders. At Naples, eight miles away, the vapor seemed to rise but slowly, but here beside it it rises majestically upward in great torrents, impelled by energies that do not sleep. Walking from the windward side around to the south margin, whose width varies from twenty to seventy-five feet, I found the steam sulphurous and irrespirable, exciting violent coughing. The summit of the crater abounds with banks of nearly pure sulphur, rocks of variegated color, and volcanic cinders. Many portions of the surface are smoking, and not a few square rods are too hot for the soles of the boots. One delights to throw rocks into the crater from whence they came, and stepping away from the precipice to dig into the noisy cinders, where evidences of great heat soon become manifest. A guide conducting an English party placed some eggs in jets of escaping steam, which soon rendered them palatable. Thrusting a paper under a rock, it immediately took fire. Fifteen feet from the precipice, beneath a layer of cinders, I found the rocks incrusted with sulphur, sal-ammoniac, and cubic crystals of sodium chloride, several times burning my fingers while throwing them into the air. Placing my green stick used for a cane in a crevice, it cracked as in a stove, and in three minutes by the watch I withdrew it all aflame.

One never tires seeing and toying with the great energies whose source is far beneath him, but whose origin lies in nebulous aggregation. One is impelled to think beyond his naked observations, and he fails not to ask, Whence this salt, which one tastes, upon the rocks? Immediately he descends far into the bosom of the earth, where he witnesses the scalding conflict between the rocks, half reddened by internal heat, and the salt water that has poured through the creviced earth from the great Mediterranean above. A simple calculation, from the quantity of steam continually poured from the crater, gives a result not easy to anticipate. A cloud, half a mile in diameter and two miles in length, condensed to saturation at 40°, represents about 20,000 cubic yards of water. Now, allowing that this vapor rises and floats away at the rate of four miles an hour, in a single day more than enough water would pass into the atmosphere to cover 104 acres to the depth of five and a half feet. Thus, in order to form a conception of one of the probable causes of volcanic action, the imagination must enable us to realize this quantity of water making its way down through the crevices beneath the adjacent sea. Understanding this fact, the difficulty of perceiving the cause of the destruction of Herculaneum is greatly removed when we think of the descending shower and the torrents of mud that must have succeeded it. If further evidence of the sinking of the Mediterranean waters were needed, it will be necessary only to state that fish have been found in the mud volcanoes of the Caspian. Admitting this, the formation of hydroxides and hydrosilicates is no longer an enigma. This theory possesses a high degree of probability, when we remember that the active volcanoes of the world are located near bodies of water. Thus are arranged the 28 active volcanoes of Java, the 109 between Australia and China, the 30 in Guatemala and S. A. Republics, the 20 active volcanoes that separate the Atlantic from the North Polar Sea, the giants of the Sandwich group, Mounts Erebus and Terror of the Antarctic continent, and in Southern Europe, Santovin, Vesuvius, Volcano, Etna, and, lastly, Stromboli, ever white with steam by day, and at night bright with his red glare. Equally striking is the correlative fact that inland from these active volcanoes are extinct ones—instance those in Eastern France, Northern Italy, in the Apennines east and southeast of Rome, and Mount Vultur, 80 miles east of Vesuvius. Throughout the 22,000 mile circle of fire which incloses the Pacific, all of its 225 active volcanoes, as well as the remaining 75 in other parts of the world (Mayer), are not distant from the sea. Whether, as Lyell maintained, volcanoes rest upon a line of fracture, is a disputed question, but the synchronous, alternate, and irregular phenomena of various volcanoes are hardly decisive.

While standing beside the Vesuvian current of flowing lava in 1819, Sir Humphrey Davy, of the Royal Institution of Great Britain, propounded a theory which, although subsequently rejected by him, exercised no small influence over the men of his time, it being advocated by Dr. Danberry, of Oxford, in his great work on volcanoes. It was very simple, supposing only the existence of free alkaline metals in the earth, to which air and water have ready access, resulting in heat and the ready flow of lava. Expressed in a concise manner, his explanation of volcanic action was the assumption of deep-seated chemical action. As an illustra-

tion of his main thought, that of chemical action. I wish to perform an experiment or two. The possibility of chemical action being sufficient to produce volcanic phenomena must be admitted by every experimenter in physics, but the great improbability of free alkaline metals or their earths (?) existing in sufficient quantities at so great a depth, or at all, is striking to the most superficial person. Perhaps the most plausible theory is that which is ascribed to volcanic action, to the existence of a fluid interior whose energies slowly radiate into space, and whose shrinking nucleus is the source of earthquakes, explosions of liquid rock, and the elevation of mountain chains. While considering physical theories of any character, we must not forget that without acute, persistent, general, and systematic observation, they are to that extent speculative and worthless. Not after observatories have been established upon the trembling sides of the volcanoes themselves, and the areas of disturbance throughout the world have been provided with seismological instruments that will automatically record the time, direction, and intensity of the subterranean forces, may we hope to lay a foundation substantial for future progress. Too many persons undertake the grandest and far-reaching generalizations, their contemporaries freely accepting or rejecting them, without a competent knowledge of the elementary facts and principles upon which they must be based. Not only in the acquirements of science but in the advancement of its state a personal knowledge of facts must precede that of its principles, and the latter that of its laws, otherwise we may not approach nearer the truth than the ancient Romans, who ascribed these phenomena to the struggling of giants overthrown by lightning from heaven, which outstretched them beneath the volcanoes, whose eruptions attest the success and sincerity of their efforts for release. We may not, like the natives of Java, annually pour rice into the crater of the Sumbing to appease the God of Destruction, nor, as did the Neapolitans for centuries, march in solemn religious procession behind the elevated bust of St. Januarius toward the invisible devil, quite successfully threatening in the crater of Vesuvius, but unless scientific questions are attacked with method, and a confidence in the uniformity instead of the confusion of law, we shall make no greater progress than they.

Laying aside the deep-seated causes, there is no concord of opinion regarding the formation of the visible part of the volcano. Conceal the upper portion of Vesuvius, we then see a truncated cone whose base sweeps the sea and beautiful Campagna in a circuit of thirty miles. No one questions that the cone above the frustum was formed by showers of volcanic sand, cinders, and lapilli, mingled with melted rock that rose from the crater—in other words, is an accumulation of matter from some point far beneath the earth's surface. A competent authority regards it highly probable that in the smoke, ashes, and cinders of Vesuvius have been carried away over the sea ten times as much matter as covered the neighboring cities and deluged her flanks. No one doubts the truth of Dryden's conception—

> "By turns a pitchy cloud she rolls on high,
> By turns hot embers from her entrails fly
> And flakes of mountain flames that lick the sky.
> Oft from her bowels massy rocks are thrown,
> And, shivered by the force, come piecemeal down."

But is it true, as Humboldt and Von Buch asserted, that volcanoes are formed by an upheaval of strata which are subsequently covered with lava, or shall we believe with Saussure and Lyell that the frustum is formed as the upper cone is formed—by an accumulation of material? This question, like most others in life, must be decided, not by an appeal to honored and reliable "authorities," but by a conscientious appeal to *facts*. The few observations made on this subject are decisive for the theory of accumulation. It is well known that the diameter of the crater and its height above the sea are continually changing, and it is probable that after it has many times blown the crater high into the air it will finally fill the atrium to the very walls of Somma. We forget that the height of the volcano is very variable. The first barometric measurement of Vesuvius was made in 1794 by Abbe Nollet, who ascertained it to be three thousand three hundred and twenty-six feet in height. Twenty-four years later it was measured by Prof. Forbes, who found that it had gained five hundred and sixty-eight feet, but in 1805, when Gay-Lussac measured it, Vesuvius had lost thirty-eight feet from its last measurement. In 1822 it was measured again by that great scientific traveler, Humboldt, whose result was four thousand and twenty-two feet, and subsequently by Schiavoni in 1863, who determined that it had gained one hundred and forty-five feet since the time of his predecessor. The last measurement was made by Prof. Palmieri, of the University of Naples, the altitude being four thousand two hundred and fifty-seven feet. But these changes in altitude have likewise been accompanied by changes in the diameter of the crater, which has oscillated to measurements greater and less than half a mile for a hundred years. Near the close of the last century its diameter was eleven hundred yards; in 1822, one thousand three hundred and twenty yards; in 1855, six hundred yards; and in 1861, seven hundred and fifty yards. These changes are constant, sometimes lowering its altitude, at other times rendering it more commanding, but enlargement is the tendency, and some time in the distant future it will have expanded so as to cover the Pedimentina, fill the great atrium, and at length assume the form and height of Vesuvius as it was in the days of heroic Spartacus and the epic times of Homer. To this future will succeed another in the Psychozoic, when to her beautiful shores there shall have been added other lands now beneath the adjacent sea; then will it be witnessed far inland, solitary as now, its stony and forbidding flanks decomposed to a rich soil, its smokeless cone washed with every storm, but its changeful physique, like its predecessor, Mt. Vultur, a long testimony to the energies that once filled it, a silent monument to the dense but forgotten populations that slept beneath the lavas or hovered about her base.—*Western Review.*

GEOLOGY OF THE POLAR REGIONS.

AT a recent meeting of the Geological Society, London, a paper was communicated by Captain H. W. Feilden, R.A., F.G.S., and Mr. De Rancé, Her Majesty's Geological Survey, on the geological results of the Polar Expedition under Admiral Sir G. Nares, F.R.S. The authors describe the Laurentian gneiss that occupies so large a tract in Canada as extending into the Polar area, and alike underlying the older Palæozoic rocks of the Parry Archipelago, the cretaceous and Tertiary plant-bearing beds of Disco Island, and the oolites and lias of East Greenland and Spitzbergen. Newer than the Laurentian, but older than the fossiliferous rocks of Upper Silurian age, are the Cape Rawson beds, forming the coast line between Scoresby Bay and Cape Cresswell, in lat. 82° 40′; these strata are unfossiliferous slates, and grit dipping at very high angles. From the fact that Sir John Richardson found these ancient rocks in the Hudson Bay territory to be directly overlaid by limestones, containing corals of the Upper Silurian Niagara and Onondaga group, Sir Roderick Murchison inferred that the Polar area was dry land during the whole of the interval of time occupied by the deposition of strata elsewhere between the Laurentian and the Upper Silurian; and the examinations by Mr. Slater, Dr. Haughton, and others, of the specimens brought from the Parry Islands, have hitherto been considered to support this view.

The specimens of rocks and fossils, more than 2,000 in number, brought by the late expedition from Grinnel and Hall Lands, have made known to us, with an absolute degree of certainty, the occurrence of Lower Silurian species in rocks underlying the Upper Silurian, and as several of these Lower Silurian forms have been noted from the Arctic Archipelago, there can be little doubt that the Lower Silurians are there present also. The extensive areas of dolomite of a creamy color, discovered by M'Clintock around the magnetic pole, on the western side of Boothia, in King William's Island, and in Prince of Wales Land, abounding in fossils, described by Dr. Haughton, probably represent the whole of the Silurian era and possibly a portion of the Devonian.

The bases of the Silurians are seen in North Somerset, and consist of finely-stratified red sandstone and slate, resting directly on the Laurentian gneiss, resembling that found at Cape Bunny and the cliffs between Whale and Wolstenholme Sounds. Above these sandstones occur ferruginous limestones with quartz grains, and still higher in the series the cream-colored limestones come in. The Silurians occupy Prince Albert Land, the central and western portion of North Devon, and the whole of Cornwallis Island. The carboniferous limestone was discovered rising to a height of 2,000 ft., on the extreme north coast of Grinnel Land, in Fielden and Parry Peninsulas, and contains many species of fossils in common with the rocks of the same age in Spitzbergen and the Parry Archipelago, being probably continuously connected with the limestone of that area, by way of the United States range of mountains. The coal-bearing beds that underlie the carboniferous limestones of Melville Island are absent in Grinnel Land, but they are represented by true marine Devonians, established in the Polar area for the first time, through the determination of the fossils by Mr. Etheridge.

In America a vast area is covered by cretaceous rocks. The lowest division, the Dakota group, contains lignite seams and numerous plant remains indicating a temperate flora; overlying the cretaceous series are various Tertiary beds, each characterized by a special flora, the oldest containing sub-tropical and tropical forms, as various palms of Eocene type. In the overlying Miocene beds the character of the plants indicates a more temperate climate, and many of the species occur in the Miocene beds of Disco Island, in West Greenland, and a few of them in beds associated with the 30 ft. coal seam discovered at Lady Franklin Sound by the late expedition. The warmer Eocene flora is entirely absent in the Arctic area, but the Dakota beds are represented by the "Atane strata" of West Greenland, in which the leaves of dicotyledonous plants first appear. Beneath it, in Greenland, is an older series of cretaceous plant-bearing beds, indicating a somewhat warmer climate, resembling that experienced in Egypt and the Canary Islands at the present time. In the later Miocene beds of Greenland, Spitzbergen, and the newly discovered beds of Lady Franklin Sound, the plants belong to climatal conditions 30° warmer than at present, the most northern localities marking the coldest conditions. The common fir (Pinus abies) was discovered in the Grinnel Land Miocene, as well as the birch, poplar, and other trees, which doubtless extended across the Polar area to Spitzbergen, where they also occur.

At the present time the coasts of Grinnel Land and Greenland are steadily rising from the sea, beds of glacio-marine, with shells of the same species as are now living in Kennedy Channel, extending up the hillsides and valley slopes to a height of 1,000 ft., and reaching a thickness of 200 ft. to 300 ft. These deposits, which have much in common with the "bowlder clays" of English geologists, are formed by the deposition of mud and sand carried down by summer torrents, and discharged into fiords and arms of the sea, covered with stone and gravel-laden floes, which, melted by the heated and turbid waters, precipitate their freight on the mud below. As the land steadily rises these mud beds are elevated above the sea. The coast is fringed with the ice-foot, forming a flat terrace 50 to 100 yards in breadth, stretching from the base of the cliffs to the sea margin. This wall of ice is not made up of frozen sea water, but of the accumulated autumn snowfall, which, drifting to the beach, is converted into ice where it meets the sea water, which splashes over it.

DYSPEPSIA.

By DR. C. F. KUNZE.*

[Translated from the German, for *The Hospital Gazette*, by PAUL H. KRETZSCHMAR, M. D., of Brooklyn, N. Y.]

DYSPEPSIA means "difficult stomach digestion," and is as such one of the most common symptoms of anatomical changes which have taken place in the stomach, but it is also a symptom of conditions *in which the normal structure of the stomach is not altered or in which, with our present state of knowledge, we are unable to detect any structural changes.* In the following pages this second form of dyspepsia only will be considered, and it may be stated here that just in proportion as our medical knowledge advances, the number of cases belonging to this class will diminish.

Symptoms.—The patients complain, especially after taking food, and sometimes only after they have eaten certain articles, *of a sensation of heaviness and fullness in the region of the stomach.* Real pain is not generally experienced. Often there is a nausea, occasionally vomiting, the stomach is bloated, *in most cases the appetite is diminished*, and, sometimes, patients have an entire lack of appetite for any kind of food. Some patients have a remarkable desire for highly spiced articles. *The stomach digestion is much slower than normal.* Percussion shows the presence of undigested food a long time after nourishment has been taken. The patient feels weary, he has no desire for mental or bodily work, and often complains of a very severe "compressing" pain in the forehead, and in the occipital region. If vomiting occurs, the food is thrown up, sometimes hours after it has been taken, in an undigested state. Not unfrequently it is saturated with foul gases, as the product of decomposition which has taken place within the stomach. If the quantity of gas present is at all considerable the stomach presents a bloated condition, known as *flatulence*, and it attempts to empty its gaseous contents by frequent eructations (ructus). Sometimes the matter vomited is of an acid reaction, depending on the presence of butyric and acetic acids. The abnormal formation of acid also gives rise to an unpleasant burning sensation in the œsophagus and pharynx (Pyrosis). The tongue is no certain criterion; in some cases it is thickly coated, in others it is entirely clean. In cases of dyspepsia of short duration, caused by an overloaded condition of the stomach, or depending on the presence of indigestible food, great relief and often permanent cure is obtained by free emesis. Not unfrequently, however, vomiting does not occur, the ingesta are not thrown up, but enter the small intestines and produce pain, cramps, rolling, flatulence, and either diarrhea or—as is often found among children—obstinate constipation. Among children such a condition is often followed by fever and restlessness at night, by increased frequency of respiration and pulse, and even by general convulsions which may prove fatal.

In *chronic cases* of dyspepsia, mental despondency and hypochondria are frequently developed: the state of the patient's nutrition becomes impaired, emaciation takes place.

The unpleasant sensations of fullness and pressure in the region of the stomach become permanent, and the patient complains about them even while the stomach is empty. At that time the symptoms frequently depend on a condition of chronic gastric catarrh, which often develops during the course of dyspepsia.

Etiology.—Dyspepsia—derangement of the digestive function of the stomach without any known structural changes—depends either on *ingesta*, or on *a disturbed condition of the general system*, or on *altered innervation.*

I. *Dyspepsia ab ingestis* is caused: (a.) by overloading the stomach with food, which by itself is not injurious, but interferes with proper digestion only by its *quantity.* To digest food properly it is only necessary that the quantity of food introduced stands in proportion to the digestive power of the stomach. If a larger quantity of food be introduced at once, the gastric juice is unable to digest all of it, the muscular action of the stomach becomes exhausted, the organ itself becomes debilitated, expanded, and the food remains longer in the stomach than normally.

(b.) By the introduction of articles which are *indigestible.* All articles which cannot be acted upon by healthy gastric juice are to be considered as belonging to this class, viz.: cartilage, tendons, tough meat generally, hard boiled albumen, etc.

(c.) By the introduction of articles which either tend *to float away or dilute* the gastric juice. Dyspepsia depending on this cause is often produced by drinking large quantities of cold or warm water in the morning—as has been recommended by Bock and others. To drink much cold water with the meals is not only injurious for its diluting effect on the gastric juice, but also because it diminishes the temperature of the stomach to such a degree as is incompatible with healthy digestion (Beaumont).

(d.) By the introduction of articles which influence the *chemical composition* of the gastric juice *unfavorably.* To this class belong the articles which prevent to a larger or smaller degree *fermentation*, viz.: strong coffee, tea, alcoholic drinks, etc.; all articles which are easily transformed into *acetic, butyric or carbonic acids* (carbo-hydrates) or those which are previous to their introduction into the stomach in a condition of *partial decomposition*, viz.: sour milk, sour lager beer, mouldy wine, etc.; or finally those articles which are *almost entirely decomposed*, viz.: old cheese, bad meat, etc. If the food, after its arrival in the stomach, cannot be digested properly, and especially if acetic and butyric acids are formed freely, the gastric juice itself becomes converted into acetic and butyric acid and a deranged condition of the digestive apparatus is developed, which is known under the name of "*dyspepsia acida.*" The secretion of these acids by the peptic glands themselves, as has been supposed in individual cases where their presence has been frequently observed, has not been proved physiologically. Conditions of the stomach peculiar to the individual have, however, a marked influence as to the predisposition to the formation of acetic and butyric acids from the food which has been introduced. This form of dyspepsia, due to the formation of acetic or butyric acids, has nothing to do with an excessive formation of hydrochloric acid, which latter is a necessary constituent of the gastric juice and is *essential* for the digestion of food. It is a wide-spread mistake that the sour eructations of patients are due to the *excessive* formation of that kind of acid which enters into the formation of the gastric juice. The recent examinations of Leube and others show that stomach digestion depends on the presence of a certain quantity of hydrochloric acid, and that dyspepsia is much oftener caused by a deficiency of hydrochloric acid than by an excess of it. Even in vomited matter of peculiarly acid smell hydrochloric acid is mostly wanting, the acid reaction being due to the presence of acetic or butyric and not of hydrochloric acid. The question whether an increased quantity of hydrochloric acid in the gastric juice is injurious has not been determined as yet; it seems to me the only action it could have would be to cause a too rapid stomach digestion.

Not unfrequently the gastric juice is observed to act in the contrary manner. It is sometimes of *alkaline reaction*, especially if large quantities of saliva are swallowed, as is found to be the case with smokers, or in cases of catarrh of the mouth and pharynx; gastric juice of alkaline reaction cannot perform its functions and dyspepsia must follow.

II. *Dyspepsia depending on a deranged condition of the general system* is found to be present in *all diseases which are accompanied by well defined febrile movements.* Beaumont observed in such a condition the direct decrease and even the suppression of the gastric juice. It seems as if, in such cases, the more rapid retrograde metamorphosis depending upon the high temperature of the body interferes with the production of gastric juice. Dyspepsia is frequently observed, and forms a very troublesome complication in cases of rachtis, scrofulosis, arthritis and diabetes, as a more or less constant symptom of the deranged condition of general nutrition. The relation which dyspepsia bears to the diseases mentioned is not altogether understood as yet.

III. *Dyspepsia depending on an altered condition of innervation* is observed in cases of hypochondria, hysteria, homesickness, neuralgia, etc. The secretion of the gastric juice depends just as much on the nervous influence as the secretion of saliva and many other functions of the different organs. Cases of dyspepsia, following the continued use of opium or other narcotics, belong to this class, though there is in such cases a mechanical influence acting which should

* The work from which this translation has been made is entitled "*Lehrbuch der Praktischen Medicin, mit besonderer Berucksichtigung der Pathologischen Anatomie und Histologie.*" Leipzig, 1878. It is a work which is considered by competent judges to be in many respects superior to Niemeyer. It was first published in Germany in 1870, and has since been translated into French, Italian, Dutch, and Spanish, and has reached its third edition in Germany. Several chapters of the translation are now ready for the press, and we shall present them to our readers as opportunity offers.

not be underestimated. From the use of the narcotics the peristaltic movements of the stomach become interfered with, lessened and sometimes lost altogether, food accumulates in the stomach, and not only causes a sensation of pressure and fullness, but also causes such conditions as were mentioned under "dyspepsia ab ingestis."

Treatment.—There is hardly any other morbid condition where it is more essential to consider the *cause* of the disturbance than in dyspepsia. In a considerable number of cases the removal of the cause is followed by complete recovery, as may be readily seen in cases of "dyspepsia ab ingestis."

Aside from the detection of the cause of the functional disturbance, the regulation of the patient's diet is the most essential part of the treatment; permanent cure can never be brought about without it.

Generally speaking, the following rules in regard to diet in dyspeptic persons may be laid down:

I. *The patient's nourishment must consist of articles easy of digestion.* To this class of foods belong soups, prepared of starchy materials, beef tea—provided it is not made too strong, and it does not contain much fat—also milk, and especially buttermilk, raw or soft-boiled eggs, white of eggs hard-boiled are not nearly so quickly digested; furthermore, venison and the flesh of pigeons or fowls, some kinds of fish, smoked ham, if soft, white bread, etc. Of those articles which should never be served at the table of a dyspeptic person the following may be mentioned: legumes, rye bread, cake, hard smoked ham, beef tea or any kind of meat with a great deal of fat, cheese, etc.

II. *Whenever the patient eats he should only take a small quantity at a time,* his stomach should never be entirely filled, he should never leave the table with feeling that his appetite is fully satisfied. To carefully regulate the quantity of food to be taken at one meal is especially important with children, as they are, in most cases, entirely unable to judge as to the right quantity of food.

III. *The patient should only be allowed to eat again when the food taken before has been properly digested and left the stomach.* In adults it takes from four to six hours for food of the average quality to be digested; in cases of dyspepsia it may require a much longer time. Infants should never be nursed at shorter intervals than every two hours.

IV. *The patient should live on plain food,* high living must be abandoned, and but few dishes should be served at a meal. He should avoid taking supper late at night, and should not go to bed with a full stomach.

If the stomach is *overloaded,* some remedy should be employed which favors the secretion of gastric juice, and which retards the decomposition of food in the stomach. It is an old and in most cases a good custom to take a small quantity of alcoholic stimulant just after finishing a rich meal. Unfortunately this custom is often abused; people think they have a right to overload their stomachs because they keep some good brandy in the house. Finally, the habitual overloading of the stomach, and the frequent use of alcoholic drinks, produce chronic gastric catarrh, often complicated by a catarrhal condition of the small intestines. It seems as if, after the introduction of very fat food, a small quantity of liquor assists in emulcifying the fatty material. The injurious habit of drinking large quantities of water must be abolished, and those who drink lukewarm water, fasting, to keep the bowels open, should consult a physician and leave it to him to correct the difficulty. I will only mention one instance which proves how much harm may be done by adopting the hydropathic method of regulating the movements of the bowels. Habitual constipation in females often depends on general anæmia; the use of warm water, or of other laxatives, while temporarily relieving the obstruction of the bowels, always increases the primary lesion, while some *light iron preparation* or the use of *Pyrmont water* frequently relieves the secondary difficulty permanently, by improving the quality of the blood.

If deficiency of hydrochloric acid in the gastric juice causes the difficulty, it is well to administer it (gtt. x: 120·0 (℥ iv) aquæ; (℥ i) 30·0 syr. simplic. one tablespoonful every two hours). If the food has undergone fermentation, the decomposed material should be removed from the stomach, either by means of the stomach pump, which is the best way, or by the use of emetics or laxatives. After the organ has been cleaned, some remedy should be employed to prevent the fermentation of food in the stomach. I like the use of sulphite of soda (2·0 to 5·0: 120·0 aquæ, a tablespoonful three or four times a day) or 20 drops of benzine in sweetened water, per dose, or of creosote (gtt. vj: 120·0, sweetened water, one tablespoonful every two hours).

In *febrile diseases* we are but rarely able to treat the dyspepsia by itself, but the remedies which are to be employed against the principal disease should be selected with due consideration for the condition of the stomach. The physician should take care to select those pharmaceutical preparations which are easily assimilated. In cases of intermittent fever with dyspepsia, muriate of quinia is to be preferred to the sulphate of quinia on account of its being better borne by the stomach.

If the dyspepsia is due to *altered innervation,* and if a so-called irritable condition of the stomach is present—persistent vomiting of almost all the food taken, a dislike to any kind of nourishment—the use of narcotics with the view of diminishing the irritability of the organ is indicated (morph. murias, aqua lauro-cerasi, tr. nuc. vomic.). The digestive properties of the gastric juice—which is secreted in diminished quantity—should be strengthened by the administration of small quantities of muriatic (hydrochloric) acid. Fresh mountain air, moderate out-of-door exercise, repeated full baths and other means to improve the general health of the patient, will assist in treating the gastric symptoms. Pepsinum porci in doses of 0·3 to 0·6 (5 to 10 grs.) with or without hydrochloric acid, to be taken three times a day just before eating, is often beneficial. Iron should *not be given in any form* as long as the digestive power of the stomach is very low. If the functional derangement of the stomach is considerably diminished, light iron-waters, such as Pyrmont, Driburg, Schmalbach, Elster, may be given, but care should be taken not to administer them at too early a period. Even with a moderate degree of irritability, the stomach cannot bear any of the iron preparations or iron waters. The bitter tonics are suitable in cases of torpid dyspepsia; I prefer to give sweet flag, calumba, quassia, or tr. gentian. comp. If there is no desire at all for nourishment, and if all sensibility of the stomach has been lost, I have frequently obtained beneficial results from moderate doses of "fruit ice"—not ice cream—and from small quantities of very old strong wine, to be taken with the meals. In cases of "nervous dyspepsia," however, no positive rule can be laid down which would answer for all conditions. Certain essential indications—the regulation of the diet, etc.—always should be observed, but besides that it is necessary to individualize each patient, and there is a large field left open for careful "trials."

The capricious stomach often cannot be controlled by the most scientific treatment, and the disease sometimes yields to the most absurd remedies.

VEGETABLE CHEMISTRY.

AT a recent meeting of the Chemical Society, London, Mr. Sidney H. Vines lectured "On the Chemical Aspects of Vegetable Physiology." The investigation of substances which occur in the cells of plants has for a long time formed a favorite theme for chemists, while the decomposition of these substances has added largely to our knowledge of chemistry. It is strange that but few researches have been made in the direction of determining the reason of the occurrence of these substances and the part that they play in the economy of the plant. One of the most typical of these substances is chlorophyll. Chlorophyll, which occurs in nearly all plants, is essential to the function of assimilation, *i. e.*, the decomposition of carbonic acid and the formation of starch in the cell, this process being accompanied by the liberation of oxygen. As early as 1690 it was observed by a French botanist that bubbles of gas were given off by green leaves submerged in water; it was next noticed that if the water had been previously boiled no gas was evolved. Priestley found that the gas given off by leaves in sunlight was of a "purer and better nature," *e. g.*, air which could not support combustion could be so purified by introducing a green plant and exposure to sunlight as to be again capable of supporting life and combustion. The next point noticed was that some sort of proportion existed between the amount of "fixed air" (CO_2) present and the "dephlogisticated air" given off. De Saussure then observed that this process was accompanied by an increase of weight in the plant. Our knowledge of the subject remained at this point till about 1837, when the circulation of starch granules was discovered and their development studied. Sachse next took up the subject and proved that starch grains were not formed in plants which are bleached from the absence of light, and that their formation in the chlorophyll corpuscles depended on the exposure of the plant to bright sunlight. Godlewski proved that if no carbonic acid was present no starch grains were formed. So we have two sets of phenomena, namely, the evolution of oxygen with absorption of carbonic acid, and the formation of starch, for both of which three conditions are essential, viz., sunlight, chlorophyll, and carbonic acid. So we may justly conclude that the two sets of phenomena belong to the same function. Starch is not the only product of this assimilation. In the onion we find no starch, but in its place another carbohydrate, grape sugar. Some experiments of Briosi, which seemed to show that substances other than carbohydrates are formed—*e. g.*, oil drops—have been lately disproved by more exact observations of Godlewski. So that as far as we know the only substances formed as a consequence of assimilation are carbohydrates, and to their formation, therefore, the increase of weight of the plant is due. De Saussure found that a plant increased in weight 531 grms., while the carbon in the carbonic acid was 217 grms. These numbers fairly correspond with the increase, supposing the carbon to unite with hydrogen and oxygen to form starch; thus—$C_6H_{10}O_5=162$ to $C_6=72$. The next points are: What is the function of chlorophyll, and what part does it play in the formation of starch? As regards the composition of chlorophyll we have but little information. There are at present several distinct views as to its proximate composition; one that it is a definite and distinct chemical entity; the second, that it is a mere mixture of coloring matters, or rather of two groups of coloring matters, one group being blue and to which the name cyanophyll is applied, the other is yellow and is termed xanthophyll. Another view, supported by Pringsheim, Karl Kraus, etc., holds that chlorophyll is nothing less than the cyanophyll of other observers, while the xanthophyll is a distinct substance which is a product of the degradation or formation of chlorophyll, but forms no integral part of it. The same diversity of evidence prevails with the ultimate constitution of chlorophyll: according to Pfaundler it contains 0·37 per cent. N, other results give 7 per cent., while a Russian observer, Timiriazoff, believes it to be an ammoniacal compound, and has called it chlorophyllin. One point seems to be agreed upon by all observers, viz., that it contains iron in its molecule. The opinions which prevail as to its action are various. Wiesner thinks that the growing cells absorb CO_2 from the air, that the chlorophyll combines with the O, while CO unites with the elements of water to form carbohydrates. The chlorophyll in its turn is deoxidized, and the oxygen thus set free evolved by the plant. So that according to this view chlorophyll acts as a carrier. Karl Kraus suggests that the process is one of reduction and that chlorophyll is formed by the combination of a substance, leucophyll (for whose existence there is no experimental evidence), with the products formed by the reduction of the carbonic acid absorbed from the air. The chlorophyll is then split up by the action of light into leucophyll and other bodies, the latter forming starch; the leucophyll recombines, and so the process goes on continuously. According to Sachse, chlorophyll is a product of assimilation, and by the further action of light is converted into starch. By the action of purpurol on resorcin coloring matters more or less remotely resembling chlorophyll have been formed. It is known, moreover, that carbohydrates can be oxidized into aldehyds and aromatic substances. From some experiments of Karl Kraus it is probable that some substance resembling an aldehyd exists in seedlings, while Gorup-Besanez has detected pyrocatechin in plants; some results of Karl Kraus seem to show that in seedlings an aldehyd and an aromatic substance unite in the dark to form ætiolin, but in the light to form chlorophyll; so that on the whole there is some foundation for the theory of Sachse, which may be summed up thus: That seedlings have the power of decomposing their stored up carbohydrates, forming acids and aromatic substances; the former are reduced to aldehyds, uniting with the latter to form chlorophyll (and in the dark ætiolin), the ultimate product being again starch. If we trace out the probable destiny of the carbohydrates we find that one portion is used to build up the vegetable cell wall, and is there deposited as lignin, etc.; a second part combines with nitrogen to form protein, but of the seat of formation of this protein we have no idea; while a third portion is decomposed into chlorophyll for the newly formed parts of the plant. If any excess remains it seems to be so stored up for another year. The lecturer then concluded this portion of the subject, merely pointing out how much remains to be done before conclusions can be arrived at with any certainty.

In the second part of the lecture Mr. Vines considered the origin of vegetable acids and their bearing on the first part of his discourse. Liebig and Mulder from observations on the ripening of fruits came to the conclusion that acids were the first products of assimilation, and from these the carbohydrates were formed. This theory breaks down under the test of experiment, and then the question arises, by what process are the acids formed in the plant, if not by assimilation? Hoppe-Seyler, by the decomposition of sugar with alkalies in the absence of air, has produced formic acid and pyrocatechin. Karl Kraus has observed in the onion, which contains much grape sugar, that from the external dry scales much pyrocatechin can be obtained; these dry scales also have deposits of calcium oxalate, while the internal scales contain only sugar, so that here the sugar is decomposed into an oxalate and an aromatic substance. In the germination of leguminous plants a substance occurs, asparagin, which has much significance in vegetable physiology. It has been found that in the germination of the leguminosæ the amount of nitrogen in the seed does not vary; the nitrogenous substance of the seed is oxidized into asparagin with the evolution of CO_2. If the germination is in the dark the asparagin accumulates, but when the plant is exposed to light the asparagin disappears and the plant forms carbohydrates. It has been suggested that asparagin is formed by some process analogous to that of digestion. It is known that some seeds contain a peptic ferment, and that aspartic acid is formed when gluten is digested by the pancreatic ferment, so that the suggestion is not without some foundation. The lecturer concluded with some remarks as to the proximate composition of seeds, about which much uncertainty exists. It is stated that seeds contain much legumin. By some of Hoppe-Seyler's pupils legumin is said to be a sort of globulin. The solanin from potatoes is now believed to resemble asparagin rather than belong to the alkaloid family. Chenopodin from the chenopodium has been said to be identical with leucin. In concluding, the lecturer said that his principal objects had been to sketch the points of contact between vegetable physiology and chemistry, and to point out the sort of information which the vegetable physiologist was most desirous of obtaining from the chemist.

The President, Dr. Gladstone, said that in listening to the lecturer, three points had especially attracted his notice: (1) That the subject of vegetable physiology was of great interest from a chemical point of view; (2) that the subject was one of which the Fellows very rarely heard anything; and (3) the very great clearness and ability with which Mr. Vines had introduced and handled the subject.

Dr. Gilbert could but agree with the President in thanking Mr. Vines for his lucid account of what is known, as well as for showing us our lack of knowledge, and indicating to us the lines of work which it was specially necessary to follow up. Mr. Vines, though principally directing his attention to the assimilation of carbon, had not omitted to refer to the assimilation of nitrogen, which, from one point of view, was even of greater importance. If he might suggest a line of research which would be of the utmost importance to agriculture, as well as interesting to the vegetable physiologist, he would recommend an investigation, especially as regards nitrogen, in plants, from the seed upward, belonging not only to the Leguminous order, but also to some widely different order, *e. g.*, a Gramineous plant.

Mr. Kingzett could but notice how much speculation existed in the various theories which had been brought before the Society. In his opinion much might be learned by studying the products of chlorophyll when acted on by different reagents. He also called attention to the great want of analytical data in the papers of Hoppe-Seyler's pupils which Mr. Vines had referred to.

Prof. Thistleton Dyer pointed out that for the study and elucidation of these processes all the delicacy of the histologist and all the analytical skill of the chemist were required. The subject could either be investigated by the vegetable physiologist from a morphological aspect, or by the chemist, who concentrated his attention on the products of the machine. The latter investigator was sometimes too apt to consider vital products as substances which could be split up by reagents. This method, although giving us much information as to the substances when dead, often furnished us with but little knowledge of their condition when alive. Some substances which were of the greatest importance to the chemist, etc., were of little interest to the vegetable physiologist, and were viewed by him as mere excretions. Thus, the cinchona alkaloids seemed to be merely casual secretions in the bark of some plants, and if the bark containing all these valuable alkaloids were removed, the plant seemed none the worse. The great problems are: How does a plant get its living? and how does it assimilate its food? It seemed to the speaker that chlorophyll brings up vegetable life to a point where fungoid growth starts. Thus, if we cut through the stem of a tree we find the outside parts green, the inside parts white, and feeding on the nourishment afforded by the external layers.

Prof. Church said that mucilage was transformed in a manner similar to starch. This was proved by experiments with the seeds of the flax plant, which contain mucilage but no starch.

Mr. Vines, in reply, thanked the Society for the kind interest with which they had listened to his lecture, and reiterated his desire for the cordial co-operation of the chemist and the vegetable physiologist. With reference to Mr. Kingzett's remarks as to speculation, he would only say that the vegetable physiologists would be only too glad to build their theories on more facts when the chemists furnished them.—*Chemical News.*

FLUORANTHENE.

THIS is a new hydrocarbon obtained by Fittig and Gebhard from coal tar (*Ber. chem. Gesell. Berlin*). In preparing and purifying a large quantity of pyrene, a substance was discovered having the formula $C_{15}H_{10}$, fusing at 109° and crystallizing in large lustrous plates: this is the new body. When created with the requisite reagents, it yielded the picric acid compound, $C_{15}H_{10}+C_6H_3(NO_2)_3O$ and the trinitro-derivative $C_{15}H_7(NO_2)_2$. When oxidized with the chromic acid solution, it, like phenanthrene, evolves carbonic acid and is converted into a mixture of a chinone and an acid having the formula $C_{14}H_8O_3$; the barium salt of this body crystallizes in little warty concretions, and the calcium salt in small golden yellow needles. It is isomeric with oxyanthrachinone, but has the same empirical formula only as that body; it is undoubtedly an acid, containing beyond all question the group COOH. When distilled with finely divided zinc it yields nearly the theoretical amount of fluorene, and when heated with lime splits up into carbonic acid and diphenylenketone, which has led the authors to give it the name of diphenylenketoncarbonic acid. Fittig believes the idryl of Goldschmiedt to be identical with fluoranthene.

AMMONIUM NITRITE.

BERTHELOT, having had occasion to repeat the experiments on the formation of ammonium nitrite by means of the electrical discharge, now finds that absolutely pure nitrogen when exposed in the concentric tubes, in contact with water, to the discharge of a very powerful Ruhmkorff apparatus for from eight to ten hours, yields ammonium nitrite beyond all question. The salt does not appear to be formed unless the discharge is a powerful one. With currents of low tension nitric acid is not formed in moist air. The formation of nitrates and nitrites in atmospheric air is assumed, therefore, to be due to the action of lightning. It must not, however, be forgotten that Zöller and Grete have reopened the inquiry whether ammonium nitrite is a product of the combustion of hydrogen in air, and the result of their experiments, conducted under most rigorous conditions, goes to show that during the combustion of absolutely pure hydrogen in perfectly pure air, small but distinct quantities of the nitrite are formed.—*Ber. chem. Gesell.*

INFLUENCE OF DIFFERENT GASES ON FERMENTATION.

THE following method has been employed by O. Nasse for investigating this problem (*Pflüger's Archiv*): He introduced ice-cold solutions of cane-sugar mixed with invertin (a ferment derived from yeast) into glass tubes, and passed various gases through them to saturation; the contents of the tubes were then gently warmed, and, after the lapse of one hour and a quarter, raised to the boiling point. The amount of inverted sugar formed in each of the tubes was then quantitatively determined. The tube through which carbonic acid had been transmitted yielded 20 milligrammes; that treated with hydrogen, 8 milligrammes; that simply exposed to the air, 7 milligrammes; while those through which oxygen and carbonic oxide had been passed contained none at all. The two last named gases, accordingly, have power to inhibit the action of the ferment; but a very small admixture of carbonic acid to either of them is enough to abolish this restraining power and to enable the fermentation to proceed. The same method of inquiry, applied to the amylolytic ferment of the saliva, furnished much less striking results; carbonic acid, however, was found to quicken the operation of this ferment, though not to any great extent. The process of death in muscular tissue was then investigated. Bits of muscle were suspended in salt solution through which carbonic acid or air was transmitted; a comparative estimate was then made of the glycogen and muscle sugar produced. The first effect of pure carbonic acid was found to be an acceleration both of the formation and the destruction of sugar, the former being more influenced than the latter; subsequently, however, both processes underwent retardation, the latter more than the former. In regard to the peripheral nerves, Nasse confirms Ranke's assertion that carbonic acid diminishes their excitability from the first (without an initial period of exaggeration), but does not annul it completely for a long time. When some other indifferent gas is substituted for the carbonic acid, the nerves speedily regain their normal excitability. But on the nerve-centers carbonic acid appears to act in much the same way as upon ferments; it first of all augments and subsequently depresses their excitability.

SUGAR IN THE ALIMENTARY CANAL.

WE are still very ignorant concerning the fate of saccharine matter contained in the digestive tube—whether introduced into it as such, or degenerated by the decomposition of amylaceous compounds. Von Mering has carried out an elaborate series of experiments on the subject in the laboratory of Prof. Ludwig (*Dubois-Reymond's Archiv*, 1877, 4 and 5). The following are the principal results of his inquiry: 1. The lacteals take hardly any part in the absorption of sugar. 2. The lymph and chyle invariably contain sugar (independently of the kind of food taken) in approximately the same proportion as the serum of the blood. 3. The blood invariably contains a certain proportion of sugar, which is the same for all the vascular areas examined, and which is not diminished by starvation, even when this is carried far enough to deprive the liver of all its glycogen. 4. The portal blood alone may sometimes contain a larger amount of sugar during the digestion of carbo-hydrates, this excess being probably withdrawn from it during its passage through the liver.

CHEMICAL ACTION OF ELECTRIC DISCHARGE.

BERTHELOT subjected 277 milligrammes of sulphuric anhydride, in contact with 60 ccm. of dry oxygen, to the action of the electric discharge for the space of eight hours; the tube containing these materials was then heated to remove a few little drops of unaltered anhydride, and he then continued the transmission of the current for some hours. By this time the anhydride had completely disappeared, and in place of it there was a substance closely resembling persulphuric acid. Rather more than 20 cc. of the gas had disappeared. The new body possessed the composition of persulphuric acid. It was found that the anhydride and oxygen, when placed together, do not enter into combination unless the electric currents are employed. Persulphuric acid prepared in this manner is not a permanently stable body. The beautiful crystalline needles commence to crumble away in a few days, and are soon converted into a snow-like mass, which appears to be a compound of sulphuric acid and persulphuric acid. The same substance is formed when the discharge is first transmitted, and consequently appears to be an intermediate product.

SEPARATION OF MINERALS.

CHURCH has recently called attention to the applicability of Sonstadt's solution to the separation of minerals of different density. The liquid consists of a solution of mercury iodide in potassium iodide, and is prepared by adding them alternately to the solution until no more of either is dissolved. A little free iodine occasionally colors the liquid; but this can be removed by the addition of some sodium hyposulphite. The light straw-colored liquid thus obtained may possess a density of 3·01, and can be employed for the separation of the mechanically-loosened ingredients of any rock which it is desired to examine. Hardman described the successful isolation of a mineral occurring in the basalt of the North of Ireland. He used a solution having a specific gravity of 2·40, and was enabled to separate two grammes of a mineral having a density of 1·70. The quantity is one which the author questions his ability to have extracted after months of hard labor by any other method. He points out that it would be possible to separate completely the three constituent minerals of granite, mica, feldspar, and quartz, to weigh them, and to determine almost absolutely their percentage, a problem which has yet only been solved by mathematical calculation, based on assumptions which can be at least only approximately correct. In the current part of the *Mineralogical Magazine*, Prof. Heddle, of St. Andrews, draws attention to two properties of Sonstadt's "solution" which cannot too soon be impressed upon those who propose to use it; it is a rapid and powerful vesicant, and is exceedingly poisonous. It happened that some drops fell upon one of his hands, which was soon found to be in a state of violent inflammation. He does not regard the liquid as a solution in the strictest sense, but believes that a new salt is formed, which crystallizes in long needles apparently belonging to the oblique prismatic system; they have a high dispersive power, a sulphur-yellow color, and are extremely deliquescent.

DETERMINATION OF THE FAT IN BUTTER.

By M. KRETZSCHMAR.

THE author has tested the method of Hehner, who saponifies the fat of butter with alcoholic potash, and always obtains from pure butter from 85 to 88 per cent. of insoluble fatty acids. The last figure is regarded by Hehner as the highest allowable for pure butter. A repetition of his experiments shows that the quantity of fatty acids amounts in cases to 90 per cent.; a higher figure shows the presence of adulterations. Among other determinations made of insoluble fatty acids are the following:

Lard	95·0 per cent.
Castor oil	96·0 "
Human fat	95·3 "

L. Liebermann has repeated the recent experiments of Kosman (*Bull. de la Soc. Chim.*, xxviii.) on the "Transformation of Glycerine into Glycose," resulting from the action of iron-foil, potassium permanganate, or bichromate of potassium, and sulphuric acid on glycerine. He finds that the reduction of Fehling's solution, regarded as the proof of the presence of glycose in the reaction-products, is due to the formation of ferrous oxide, lower oxides of manganese, or chromic oxide, and that no change into sugar takes place.

J. Barsylowsky has obtained "M-Azo-toluen," $C_{14}H_{14}N_2$, by treating m-nitro-toluen with alcoholic potash and zinc. It forms large orange-red crystals, melting at 54°, and completes the series of the three isomeric azo-toluens.

A. Naumann details more particularly his "New Method of Determining Molecular Weights." As already communicated, he has ascertained that when the vapors of one liquid are driven through another liquid—with which it does not mix—the ratio between the quantities of the two liquids in the distillate, expressed in terms of their molecular weights, is equal to the ratio between the tensions of the vapors of the two liquids at the temperature at which the mixture distills. The practicability of this process for the determination of molecular weights may be seen from the following table of experiments carried out with steam. The first column contains the specific weights of the various substances, the second their boiling points, the third the temperature by the distillation with steam, the fourth the ratios between the quantities in the distillate expressed in terms of the molecular weights, and the fifth the ratios between the tensions of the vapors of the two liquids according to the temperature in column three:

	I.	II.	III.	IV.	V.
C_6H_6	0·877	79·5°	69·1°	0·410	0·420
$C_6H_5CH_3$	0·865	108·5	84·0	1·270	1·260
CCl_4	1·599	76·1	66·7	0·360	0·360
$C_6H_5NO_2$	1·206	208·0	99·0	38·500	33·30
C_3H_5Br	1·407	72·0	37·0	0·064	0·065
$C_7H_8O_2C_3H_5$	1·048	213·0	99·1	49·910	45·99
$C_{10}H_8$	—	218·0	98·8	38·980	36·40

As will be noticed, the slight differences in the last two columns are not sufficient to prevent a perfectly reliable determination as to whether the molecular weight of a body should be doubled or halved, and the new method can be used to advantage in settling many disputes as to the formulæ of organic compounds.

ACTION OF HYDROCYANIC ACID.

By O. WALLACH.

THE author shows that the transformation of chloral into dichlor-acetic acid by the action of CNK is not due to the weak alkaline properties of the latter, but to the presence of free hydrocyanic acid, and that a small quantity of HCN is sufficient to change unlimited amounts of chloral into the acid. The reaction results from the tendency of HCN, as nitrile of formic acid, to decompose water into its components (forming NH_3 and CO and—

$$CO+H_2O=CH_2O_2),$$

combined with the inclination of chloral as an aldehyd to take up an additional atom of O, and its readiness to exchange Cl for H and form HCl. Before these united attractions the water present in the reaction is decomposed, but the hydrogen and oxygen thus set free are entirely appropriated by the chloral, which has the strongest affinity for the two elements. A similar catalytic action of CNH has been noticed in the case of alloxan, and gly-oxalic acid, and it is probable that the physiological action of the acid is due to an analogous influence on the oxidizing and reducing agencies in the animal organism.

HYDROCYANIC ACID.

BÖTTGER has devised a lecture experiment to demonstrate the presence of traces of this acid, and to show its direct production in bitter almonds or the kernels of plums and cherries by the action of water when heat is applied. Some freshly crushed bitter almonds are to be placed in a flask, two liters in capacity, and over them is to be suspended a long strip of Swedish filter-paper, which has first been moistened with alcoholic extract of guaiacum (5 grammes of the resin in 100 cc. of alcohol), then dried and subsequently saturated with a dilute solution of copper sulphate (1 part of sulphate in 2,000 parts of water). The strip of paper remains colorless until the crushed kernels are warmed with a little water, when in the space of a few moments it is observed to acquire an intense blue color.—*Poly. Notizbl.*

GREEN AND BLUE ULTRAMARINE.—(Second paper.)—DR. J. PHILIPP.—In this important communication the author shows that green ultramarine is distinguished from the ordinary blue kind merely by the presence of sodium sulphide.

FLUID CAVITIES IN BLENDE.

A. SCHERTEL has observed the occurrence of a cavity, of the size nearly of a pea, and filled with liquid, in a specimen of Spanish blende. When the specimen was broken through the liquid was ejected. The walls of the cavity and the cleavage-faces were washed with distilled water and the transparent liquid qualitatively examined. The liquid appears to have contained sodium chloride and zinc sulphate, the former predominating (*Berg. und Hüttenm. Zeitung*). Little cubes of salt have not unfrequently been observed in the fluid cavities of other minerals.

MELTING POINTS.

BERTHELOT finds that crystallized phosphoric acid, PO_4H_3, melts at 41°·75; the fused mass remains liquid at 38°, and at the moment it solidifies the thermometer again rises to 40°·5. The presence of a mere trace of water suffices to lower the fusing-point considerably. Nitric monohydrate fuses at —47°; this point is, however, probably a little too low. The acid was solidified by employing a mixture of solid carbonic acid with ether. Chloroform melts in the same mixture at —70°. These points were all observed by aid of a small air-thermometer, an instrument which appears to be equally adapted to the determination of very low or very high temperatures. The boiling point of carbonic acid, as indicated by this thermometer, was found to be —78°·2; Regnault's earlier determination was —77°·9. —*Bull. Soc. Chim.*

ANALYSIS OF SOILS.

By AD. MAYER.

THE author concludes that the determination of phosphoric acid alone gives a good clew to the quality of a soil. If an unfruitful soil contains a fair proportion of phosphoric acid, the cause of its barrenness is probably not the absence of plant-food, but the presence of some positive but less easily detected cause of fertility.

ALCOHOLIC POTASSA.

By E. J. MAUMENÉ.

THE author maintains that alcoholic solutions of potassa are converted, in course of time, into dihydrodedate of potassa, a neutral anhydrous salt, formed by an acid richer in hydrogen than any other known, $C_4H_2O_4$. This salt is rendered anhydrous by desiccation at 100°. It is deliquescent, especially in moist air, and its solution has a very faint and slightly bitter taste. Its action with metallic salts is very characteristic; if concentrated, it forms in all a magma, very similar to that produced by the mixture of caustic potassa with calcium chloride. If diluted, it precipitates ferric, mercuric, plumbic, and platinic solutions. The ferric precipitate is a yellowish white, and is re-dissolved by boiling with an excess of hydrodedate; that of silver is of a pale yellow, like silver phosphate, but becomes black in a short time. That of platinum (chloride) is the double chloride of platinum and potassium, and its formation is accompanied by a brisk effervescence. The same phenomenon is still more marked with bismuth nitrate where a white precipitate is deposited. Gold chloride gives no precipitate in the cold, but merely a faint brown coloration. On ebullition gold separates out, and the liquid takes a pale violet coloration. Chrome-alum, ammoniacal or potassic, gives a deposit which easily re-dissolves if the chrome is in excess.

HYDROGEN PEROXIDE.

PROF. E. SCHÖNE, of Moscow, has published two books containing numerous and valuable experiments on hydrogen peroxide, and on the occurrence of ozone and hydrogen peroxide in the atmosphere. Prof. Schöne comes to the following conclusions: Sunlight accelerates the decomposition of hydrogen peroxide in aqueous solutions; this compound is not an electrolyte. The reaction which takes place between ozone and hydrogen peroxide in the presence of water is the following:

$$H_2O_2+O_3=H_2O+2O_2.$$

The presence of ozone in the atmosphere cannot be strictly detected by Houzeau's or Schonbein's ozonometrical papers; also the presence of ozone in the atmosphere is not ascertained; but hydrogen peroxide was found to be one of the normal constituents of the atmosphere. Experiments proved that in summer time the atmosphere contains a higher percentage of hydrogen peroxide than during the winter. The higher from the surface of the earth commences the condensation of the clouds the greater is the percentage of hydrogen peroxide in the air. Hydrogen peroxide combines readily with the peroxides of barium, sodium, and potassium, and yields compounds of the following composition:

$$BaH_2O_4, Na_2H_4O_6, K_2H_4O_6.$$

During Schöne's experiments, all the year round, he found that 1 square meter of earth absorbs 710 milligrms. of hydrogen peroxide—a very small quantity indeed; but when we remember that very small quantities of ammonia and nitric acid have an influence on vegetable life, we may also suppose that the hydrogen peroxide of the air also plays a necessary part in nature's economy.

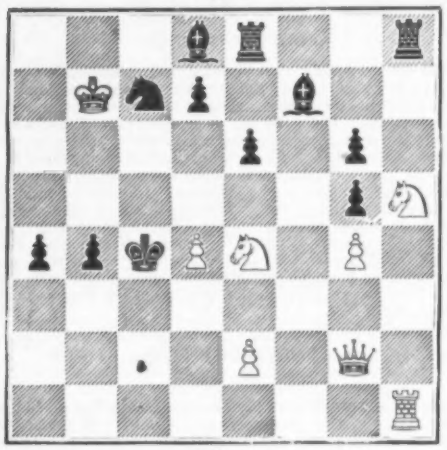
STUDIES ON THE COMPOUNDS OF THE CAMPHOR GROUP.—J. KACHLER.—In this, his fifth paper on the subject, the author treats of the oxidation-products of camphor, of the salts of hydro-oxy-camphoronic acid, of dinitro-hephthylic acid, and its behavior respectively with sodium amalgam, with tin and hydrochloric acid, with caustic alkali, with hydrate of baryta, and with bromine; also of mono-nitro-hephthylic acid, and its reactions with tin and hydrochloric acid, and with hydrate of baryta.

ON CURARIN.—THEODOR SACHS.—The author criticises the results obtained by Dr. Preyer in 1865 (*Journal fur Prakt. Chemie*, 98, p. 228), and shows that the crystalline "curarin sulphuricum" of the latter is impure, containing phosphate and carbonate of lime, and is, moreover, almost inert in a physiological point of view. He finds that Preyer's process for the isolation of curarin is impracticable, since curare gives up mere traces of soluble matter when treated with absolute alcohol. Curarin gives with sulphuric acid not a blue color, as asserted by Preyer, but a red. In crude curare it occurs not as an acetate, but a sulphate. With the sodium chloride of platinum curarin gives a bulky faint yellowish white precipitate, which is quickly decomposed, taking a violet color, the intensity of which keeps increasing.

SCIENTIFIC AMERICAN CHESS RECORD.

[All contributions intended for this department may be addressed to SAMUEL LOYD, Elizabeth, N. J.]

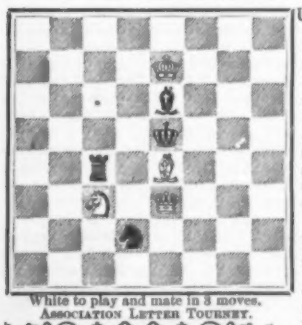
PROBLEM No. 90.—BY RUDOLPH WILMERS, of Vienna.
First Prize in the American Chess Congress of 1857.
Black.



White.

White to play and mate in four moves.

J. A. DE RIVIERE, OF PARIS.



White to play and mate in 3 moves.
ASSOCIATION LETTER TOURNEY.

JUDGING from the increasing interest taken in the forthcoming Paris Tournament, this contest will form a most important event in the annals of chess, and there will be a struggle for the prizes such as no other tournament has ever elicited.

America will be represented by Mason and Mackenzie, while England and Germany will each furnish half a dozen renowned champions, while, curious as it may appear, France alone—the land of Philidor, La Bourdonnais, and St. Amant—seems to have taken no steps whatever to battle for their flag, and seem to rely upon the prowess of Mr. Rosenthal, a Polish player of acknowledged brilliancy, but sadly deficient as a match or tournament player.

Where is our old friend De Riviere?—the acknowledged champion of France, and in all probability the strongest player France has ever produced—of whom Morphy said he was the best player he had met in Europe, and of whom Steinitz says, in the last issue of the *Field*, that he is the only French player who could hope to compete successfully for the prize.

We have seen no mention of his name in connection with the present tournament, and, in fact, have heard from him but twice since the tournament of 1868.

De Riviere is a most skillful player, and has been one of the leading champions of Europe for over a quarter of a century; a man of rare attainments and ability, but whose active business pursuits never allowed of his devoting the necessary time to keep in good practice; hence his want of success at the tournament of 1868, although in the series of matches he then played he was most successful.

We give a pencil sketch made of him at that time, which was pronounced a most faithful likeness; but ten years have passed since then, and we are often surprised to find that some of the players who were then in their prime; are now well advanced in years, and have withdrawn from active play.

We contested more games with De Riviere than with any other player in Europe, and have always felt proud that out of a long score of games we can claim the majority of one game, and can be excused therefore if we present that one game to our readers, not for any merit in the play, but for the curious termination, which is the only game we have ever seen wherein a game was won through the knighting of a pawn. The game never having been correctly printed.

[*Scotch Gambit.*]

DE RIVIERE.	LOYD.
WHITE.	BLACK.
1. P to K 4	1. P to K 4
2. Kt to K B 4	2. Kt to Q B 3
3. P to Q 4	3. P x P
4. Kt x P	4. Kt x Kt
5. Q x Kt	5. P to Q 3
6. P to K B 4	6. P to K B 4
7. B to B 4	7. Kt to B 3
8. Castles.	8. P x P
9. Kt to B 3	9. P to B 4
10. Q to Q sq	10. B to Kt 5
11. B to Kt 5 ch	11. B to Q 2
12. B to B 4	12. B to B 3
13. B to K 6	13. Q to K 2
14. P to B 5	14. B to Q 2
15. Kt to Q 5	15. Kt x Kt
16. Q x Kt	16. B to B 3
17. Q to Kt 3	17. K to Q sq
18. B to K B 4	18. K to B 2
19. Q to K Kt 3	19. P to K R 3
20. Q R to Q sq	20. R to Q sq
21. R x P	21. R x R
22. R to Q sq	22. Q to Q sq
23. P to Q B 4	23. P to Q Kt 3
24. P to K R 4	24. P to K 6
25. K to B sq	25. B to K 5
26. R x R	26. B x R
27. Q x P ch	27. K to B 3
28. B x B	28. Q x B
29. B to Q 5 ch	29. B x B
30. P x B ch	30. K to Kt 4
31. P to R 4 ch	31. K to R 3
32. Q x R	32. Q to B 5
33. K to K 2	33. Q to B 7 ch
34. K to Q 3	34. P to K 7
35. Q to B 8 ch	35. K to R 4
36. Q to Q 7	

And black mated in two moves.

AMERICAN CONGRESS TOURNEY OF '57.

IN looking over a bundle of old letters the other day, we were forcibly reminded of this problem tournament by a letter from D. W. Fisk, dated Nov., 1858, in which he forwarded the umpire's award in the above tournament, adding "I saw Cook, who told me privately that one of your tourney problems was faulty, so you don't get the first prize with your usual luck."

The above postscript brings the matter back most vividly to our minds, and is an incident which we see no harm in mentioning now at this late day. We were then residing at Florence, N. J., and well remember the consternation of the young lad upon learning that one of his set was "faulty." We spent several days examining and searching for the flaw, failing of which we started for New York, hunted up Mr. Fisk, and in his company started for Hoboken to interview the umpire, when, to our horror, we found that the problem was not faulty, but that the solution had not been given correctly. Of course it was too late to remedy the mistake, as the award had been published and the prizes paid, and the fault was our own. We were therefore well satisfied to learn

J. A. DE RIVIERE, OF PARIS.

that the balance of our set had earned honorable mention, and that this special one, on which he had bestowed more labor than on any other composition, would be referred to as "wonderfully elaborate" in the report.

We are not sure that the verdict would have been reversed if we had been more careful in writing out our solution, but the probabilities are that we would have received a prize, as complicated problems were much in vogue in those days, and the position (which we give as No. 91) is the most elaborate affair we have ever attempted, although our views have so modified during the intervening score of years that we would not attempt a problem of that description now.

Two prizes were offered for the best sets of three problems: 1st. Thirty dollars and five copies of the Congress Book. 2d. Fifteen dollars and three copies of the book.

There were eleven sets received in competition, and the first prize was awarded to Rudolph Wilmers, of Vienna, and the second prize to Conrad Bayer, of the same city, each entering three four-move problems. Problem No. 90 is the first of the set by Rudolph Wilmers, and the following is the first of the set by Conrad Bayer:

ENIGMA No. 57.—BY CONRAD BAYER.

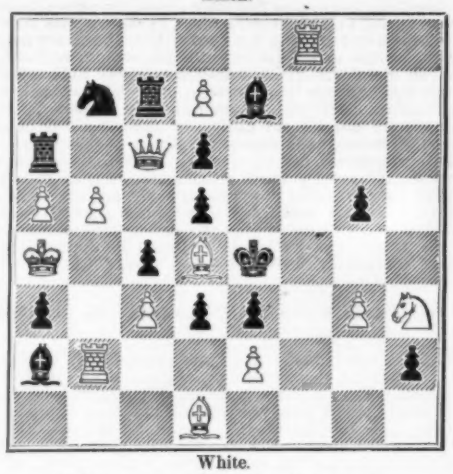
Second Prize in the American Congress of 1857.

White.—K on Q 2, Q K B sq, R K sq, B Q B 3, Kt K B 2, Ps Q R 2, Q Kt 5, K B 4 and K Kt 3.
Black.—K Q 4, Q Q Kt sq, Rs K Kt sq and K R 4, B K R 3, Kt Q Kt 2, Ps Q R 4, Q 3 and K Kt 5.
White to play and mate in four moves.

CHESS AND THE CATHOLIC CLERGY.

VERCI, in his entertaining and valuable Letters on Chess, says that the game is certainly not comprehended in the canonical prohibitions of the Catholic Church, and quotes two different passages to support his assertion. He finally remarks: "From this and from the text, the inference is drawn that chess is not prohibited to clerks, and much less to laymen; and this is commonly held. * * * Chess is not prohibited, because it rather sharpens the ingenuity of man." Salvio, a much older Italian writer, has the following curious statement on the subject: "It is also confirmed by the canon law that priests are permitted to play at chess; and even if any priest or clerk playing at chess, and a quarrel consequently arising, should kill his adversary, such homicide should be accounted casual and not intentional; which would not be allowed after any other game, and the reason is because *dabat operam rei licitæ*. Thus say Innocent and Il Panormitano, and others, in *Cap. Lator de Homicid.*" In spite of such high authority, we do not advise players to split the chess board over the heads of their opponents, in the belief that they will be acquitted by the jury. Moreover, Johannes Geyler, a priest who composed a whimsical book of sermons at the latter end of the fifteenth century, which he quaintly entitled *Navicula sive Speculum Fatuorum*, is also of the opinion that chess is not a prohibited game. His words are: "There are some games invented for children. Cato says, play with a top. Others for grown boys, as the game of ball. Others for young men, as pitching the bar, and running for men. Others for older men, as the game of chess, which sport is not forbidden even to the clergy."

PROBLEM No. 91. BY SAMUEL LOYD.
Honorable Mention in the American Congress of '57.
Black.



White.

White to play and mate in five moves.

SOLUTIONS TO PROBLEMS.

No. 84.—BY W. MERIDITH.

WHITE.	BLACK.
1. Q to Q 6	1. B x Q ch
2. Kt to B 5 dble ch	2. K to K 4
3. Kt to Q 7 mate.	
	1. Q x Q
2. Kt to B 2 ch	2. K to K 4
3. Kt to Kt 4 mate.	
	1. B x B
2. Q to K B 4 ch	2. K x Kt
3. Q to Q B 4 mate.	

No. 85.—BY J. B. CHERRIMAN.

WHITE.	BLACK
1. R to K B 8 ch	1. Kt to Kt sq
2. Q to K B 6 ch	2. Q to Kt 2 ch
3. Kt to K 6 ch	3. P x Kt
4. Q to R 4 mate.	

LETTER "L."—ASSOCIATION TOURNEY.

WHITE.	BLACK.
1. B to Q Kt 3	2. Q x Q
2. Kt to K 6 mate.	

ENIGMA No. 50.—BY KLING AND HORWITZ.

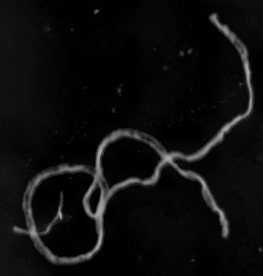
WHITE.	BLACK.
1. B to Kt 2 ch	1. K to Kt sq
2. B to Kt 7	2. B to R 5 (best)
3. Kt to B 4	3. B to K 2
4. Kt to Q 5	4. B to Kt 4 (best)
5. B to B 3	5. B to B 8
6. Kt to B 6 ch	6. K to R sq
7. Kt to K 4 ch	7. K to Kt sq
8. B to Kt 7	8. B to Kt 4
9. Kt to Q 6	9. B to K 2
10. B to B 6 and wins	

ENIGMA No. 51.—BY KLING AND HORWITZ.

WHITE.	BLACK.
1. Q to Q R sq	1. Q to Q B sq ch
2. K to Q Kt 6 ch	2. K to Q Kt sq
3. Q to R 2 ch	3. K to Q R sq
4. Q to K Kt 2 ch	4. K to Q Kt sq
5. Q to K Kt 3 ch	5. K to Q R sq
6. Q to K B 3 ch	6. K to Q Kt sq
7. Q to K B 4 ch	7. K to Q R sq
8. Q to K 4 ch	8. K to Q Kt sq
9. Q to K 7 and wins.	

ENIGMA No. 52.—BY W. A. SHINKMAN.

WHITE.	BLACK.
1. Kt to Q B 6	1. P to Kt 3
2. Q R to K 5	2. P to Kt 4
3. Q Kt to K 7	3. K x R
4. Kt to Q 5 mate	
	1. P x Kt
2. R to Q R 5	2. P to B 4
3. R x R P	3. P to B 5
4. R to K B 3 mate.	

ENIGMA No. 53.—BY H. R. AGNEL.

WHITE.	BLACK.
1. Q to Q sq ch	1. K x Q
2. R to Q B 4 dis mate.